Overweight in 5-year-old Children: Assessment and Risk Factors

The 'Be Active, Eat Right' Study

LYDIAN VELDHUIS

OVERWEIGHT IN 5-YEAR-OLD CHILDREN: ASSESSMENT AND RISK FACTORS

– The 'Be Active, Eat Right' Study –

OVERGEWICHT BIJ 5-JARIGE KINDEREN: SIGNALERING EN RISICOFACTOREN

– Het 'Lekker bewegen, goed eten' onderzoek –

Lydian Veldhuis

ISBN: 978-94-6169-444-7

Lay-out and printing: Optima Grafische Communicatie, Rotterdam, the Netherlands
Dit proefschrift is te downloaden via *www.e-pubs.nl/?epub=lydianveldhuis*

The studies presented in this thesis were financially supported by a grant from ZonMw, the Netherlands Organization for Health Research and Development
(grant number 50-50110-98-355).

The financial support by the Department of Public Health, Erasmus MC, Rotterdam, and the Erasmus University Rotterdam for publication of this thesis is gratefully acknowledged.

Overweight in 5-year-old Children:
Assessment and Risk Factors

– The 'Be Active, Eat Right' Study –

Overgewicht bij 5-jarige kinderen:
signalering en risicofactoren

– Het 'Lekker bewegen, goed eten' onderzoek –

Proefschrift

ter verkrijging van de graad van doctor aan de
Erasmus Universiteit Rotterdam
op gezag van de
rector magnificus

prof.dr. H.A.P. Pols

en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
dinsdag 4 februari 2014 om 15.30 uur

door

Lydian Veldhuis
geboren te Hoorn

PROMOTIECOMMISSIE

Promotoren:	Prof.dr. H. Raat
	Prof.dr. R.A. HiraSing
Overige leden:	Prof.dr. H.A. Moll
	Prof.dr. J.J. van Busschbach
	Dr. M.M. Boere-Boonekamp
Copromotor:	Dr. C.M. Renders

CONTENTS

1

General introduction

INTRODUCTION

The World Health Organization defines overweight and obesity as "abnormal or excessive fat accumulation that may impair health".[1] Worldwide, about one in ten children at the age of 5 to 17 years have overweight (obesity included).[2] In the last decades there has been a dramatic increase in the prevalence of childhood overweight and obesity in many countries.[2, 3] This increase over a relatively short period of time and within a relatively stable population indicates that genetic factors can not be the primary reason for the increase.[2] The fundamental cause of overweight and obesity is an imbalance between energy intake and energy expenditure,[1, 4] and the increase in prevalence has been ascribed to changes in society that increase the energy intake and decrease the physical activity of the population.[1, 2] An environment with factors that facilitate the development of overweight and obesity is also referred to as an obesogenic environment.[2] Children with overweight are at risk of developing obesity, and childhood obesity is associated with an increased risk of health problems already during childhood (e.g. cardiovascular risk factors, type 2 diabetes, asthma and psychosocial problems).[1, 2, 4, 5] However, the greatest health problems will be seen in next generations as overweight and obesity track from childhood into adulthood quite strong.[2, 5-7] Childhood overweight and obesity have been associated with higher morbidity and mortality later in life.[1, 8] Further, once childhood obesity is established, it is difficult to reverse.[9] Childhood overweight and obesity are therefore a major burden on health care, and prevention of childhood overweight and obesity is an international public health priority.[10] In the Netherlands, the prevention of overweight in children appeared as a priority on the political and public health agenda at the beginning of this century. As a result, the overweight prevention protocol for use in the setting of youth healthcare was developed in 2005.[11]

This thesis reports on a number of studies examining overweight assessment and risk factors for overweight in young children. These studies are embedded in the 'Be active, eat right' study. The 'Be active, eat right' study was initiated to implement the overweight prevention protocol in the youth healthcare setting, and to assess its effects on the prevalence of overweight and health behavior of children. A cluster randomized controlled trial was initiated with a follow-up period of 2 years. Data was collected during the 2007-2008 school year among 5-year-old children. The same children were also measured 1 year later (2008-2009) and after 2 years (2009-2010) when the children were 7 years old. Interventions for overweight prevention should start preferably early in life. Children were included at the age of 5 years, because at this age all children and parents in the Netherlands are invited for a regular well-child visit by youth healthcare professionals of municipal health services. The studies in this thesis are based on the data of the 'Be active, eat right' study collected at baseline, when the children were at the age of 5 years.

The overweight prevention protocol has now been evaluated and the effects have been reported; limited effects on health behavior and BMI of the children were found.[12, 13] The overall aim of this thesis is to provide new insights into overweight assessment and risk factors for overweight in young children. These new insights might lead to adjustments of the overweight prevention protocol that in turn might lead to more success in the prevention of childhood overweight and obesity. In this general introduction, childhood overweight in the Netherlands and the development of the overweight prevention protocol are described. The aims and the outline of this thesis are described at the end of this chapter.

PREVALENCE RATES IN THE NETHERLANDS AND DEVELOPMENT OF THE OVERWEIGHT PREVENTION PROTOCOL

In the Netherlands, the prevalence rates of overweight and obesity among children more than doubled since 1980 (see Figure 1.1). Of all Dutch boys aged 2-21 years, 13.3% had overweight and 1.8% had obesity in 2009. Among girls the prevalence of overweight and obesity is higher; of all Dutch girls aged 2-21 years 14.9% had overweight and 2.2% had obesity in 2009. Among 5-year-old boys the prevalence of overweight and obesity was 5.2% and 0.3% in 1980. In 2009, these rates were 12.8% and 2.0%. Among 5-year-old girls the prevalence of overweight and obesity was 8.6% and 0.8% in 1980; in 2009 these rates were 18.1% and 3.3%. It has been indicated that the rise in prevalence rates has now slowed down or even plateaued.[14]

In the Netherlands, all children are monitored at set ages during well-child visits by youth healthcare professionals of municipal health services. This nationwide monitoring program is free of charge, and the attendance rate for the well-child visits is 95%. During the regular check-ups, youth healthcare professionals measure height and weight of each child.[16, 17] Over the years, youth healthcare professionals observed the increasing number of children with overweight and obesity. There was a need for a uniform method to detect childhood overweight and obesity. This led to the development of an overweight detection protocol for children in 2004. According to this protocol, youth healthcare professionals assess a child's weight status based on the child's body mass index and complement this with their clinical judgment taking into account the child's stature, ethnicity, and body-fat distribution.[16]

Subsequently, when a child has overweight, the child and parents should be offered an intervention to prevent further development of overweight and obesity. The nationwide monitoring program has a high attendance rate and therefore serves as a unique setting to monitor children's growth, development, and behavior, and this creates excellent opportunities for prevention of childhood overweight and obesity. No evidence-based interventions

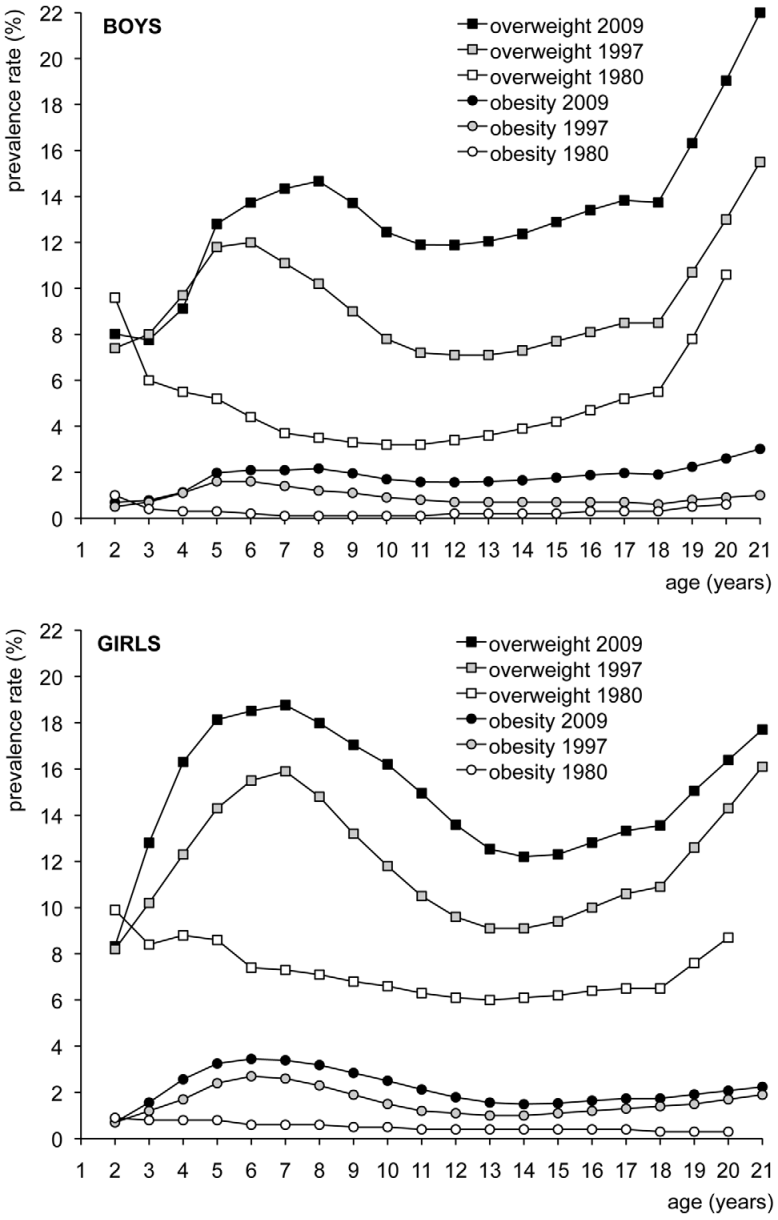

Figure 1.1 Prevalence of overweight (including obesity) and obesity in Dutch boys and girls according to age (TNO, 2011)[14] based on the age-specific and sex-specific cut-off points for the body mass index, presented by the International Obesity Task Force[15]

to prevent childhood overweight and obesity were present for this setting. However, doing nothing and wait for an intervention which was proven to be effective was not an option according to the Dutch Ministry of Health: it was time to act. Therefore a theory and practice-based childhood overweight prevention protocol was developed in 2005 for use during the well-child visits.[11]

To develop the overweight prevention protocol, the following activities were employed: 1) a literature search to assess promising elements to prevent childhood overweight and obesity, 2) consultation of experts in the field of overweight and child health, 3) an expert meeting among youth healthcare professionals aimed at making the protocol applicable within daily practice and creating commitment among the youth health professionals, and finally 4) a pilot study. Based on the scientific literature, the following 5 promising elements for the prevention of childhood overweight were found: 1) stimulating breastfeeding, 2) stimulating to have breakfast regularly, 3) reducing the intake of sweet beverages, 4) stimulating physical activity (especially playing outside), and 5) reducing watching TV and using (game) computers.[11, 17] In the pilot study, the protocol was further developed into an intervention following the method of Intervention Mapping.[18] According to this method, the intervention was developed based on theories and models of behavioral change (i.e. the ASE model, a theoretical model of exercise habit formation, the Precaution Adoption Process Model, the Elaboration Likelihood Model, the stages of change model, and motivational interviewing techniques) and systematic health behavior intervention planning.[18] In the pilot study the feasibility and acceptability of the overweight prevention protocol were established, but no conclusions about the effectiveness of the protocol could be made. The overweight prevention protocol is theory and practice-based, and is meant to 'bridge the gap' until an evidence-based protocol is available for the youth healthcare setting. To obtain evidence about the effectiveness of the overweight prevention protocol, a study was needed to implement the protocol in the youth healthcare setting and to assess its effects.

AIMS AND OUTLINE OF THIS THESIS

The overall aim of this thesis is to provide new insights into overweight assessment and risk factors for overweight in young children, which might improve the prevention of childhood overweight and obesity. The aims of this thesis are:

1. To develop a study to implement and evaluate the overweight prevention protocol. (Chapter 2)
2. To investigate the agreement between the body mass index and measures of waist circumference in the identification of overweight among 5-year-old children. (Chapter 3)

3. To investigate the associations between socioeconomic status, ethnic background, and overweight among 5-year-old children. (Chapter 4 and 5)
4. To investigate the associations between lifestyle-related behaviors and overweight among 5-year-old children. (Chapter 6)
5. To investigate the associations between parenting style, the home environment, and screen time of 5-year-old children. (Chapter 7)

The next chapter of this thesis, **chapter 2**, describes the development and the design of the 'Be active, eat right' study, in which the overweight prevention protocol was implemented and that aimed to assess the effects of this intervention on the prevalence of overweight and health behavior of children. This corresponds with step 5 and step 6 of the model for Planned Health Education and Promotion as shown in Figure 1.2.[19]

After development (step 4, which is not part of this thesis as the overweight prevention protocol was already developed) and implementation (step 5) of an intervention, the intervention should be evaluated continuously and should be adjusted, refined, and improved to increase its quality.[20] To achieve this, each step described in the model for Planned Health Education and Promotion (Figure 1.2) can be followed.

Chapter 3 of this thesis focuses on the identification of overweight among 5-year-old children, and describes the agreement between the body mass index and measures of the waist circumference in identifying overweight (step 1). Chapter 4, 5, and 6 further increase the existing knowledge about subgroups in the population that are at increased risk for childhood overweight, and risk behaviors for childhood overweight (step 2); **chapter 4 and 5** describe differences in overweight (including obesity) among subgroups of 5-year-old children

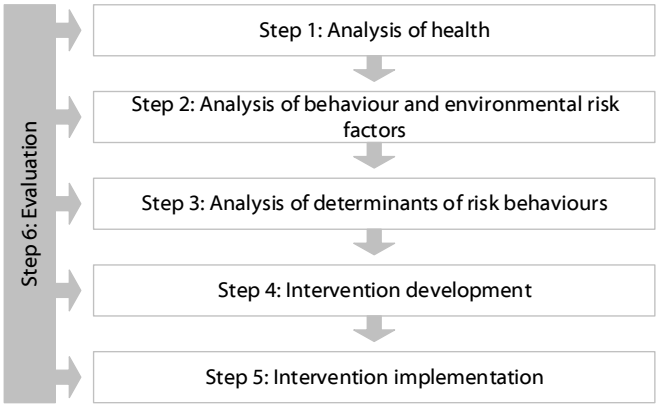

Figure 1.2 A model for Planned Health Education and Promotion (based on Brug J. et al, 2005)[19]

Table 1.1 Overview of the studies presented in this thesis

Chapter	Population for analyses	Determinants	Outcome	Corresponding step Figure 1.2
2	Development and design of the 'Be active, eat right' study			Step 5 + Step 6
3	n=7703	- Child's body mass index - Child's waist circumference - Child's waist-height ratio	Child's weight status	Step 1
4	n=5582	- Maternal educational level	Child's weight status	Step 2
5	n=7801	- Child's ethnic background	Child's weight status	Step 2
6	n=7505	- Child's lifestyle-related behaviors (having breakfast, drinking sweet beverages, playing outside, watching TV)	Child's weight status	Step 2
7	n=3067	- Parenting style, social and physical home environment	Child's screen time (watching TV and using (game) computers)	Step 3

with mothers with different educational levels (as an indicator of socio-economic status) and subgroups of 5-year-old children with different ethnic background, and the influence of (socio)demographic and lifestyle-related characteristics on these differences. **Chapter 6** describes the associations between the four lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside (as an indicator of physical activity), watching TV, and overweight (including obesity) among 5-year-olds. **Chapter 7** describes the associations between parenting style and the social and physical home environment on watching TV and using (game) computers among 5-year-old children (step 3). In the final chapter of this thesis, **chapter 8**, an overall discussion is presented with recommendations for future research and for the practice setting. Table 1.1 provides an overview of the studies presented in this thesis.

REFERENCES

1. World Health Organization. Factsheet Nº311, Obesity and overweight: World Health Organization; March 2013. Available from: http://www.who.int/mediacentre/factsheets/fs311/en/ (accessed 5 July 2013).
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
3. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes*. 2006;1(1):11-25.
4. Kipping RR, Jago R, Lawlor DA. Obesity in children. Part 1: Epidemiology, measurement, risk factors, and screening. *BMJ (Clinical research ed*. 2008;337:a1824.
5. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, et al. Health consequences of obesity. *Archives of disease in childhood*. 2003;88(9):748-752.
6. Krebs NF, Himes JH, Jacobson D, Nicklas TA, Guilday P, Styne D. Assessment of child and adolescent overweight and obesity. *Pediatrics*. 2007;120 Suppl 4:S193-228.
7. Singh AS, Mulder C, Twisk JW, van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9(5):474-488.
8. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes (Lond)*. 2011;35(7):891-898.
9. Oude Luttikhuis H, Baur L, Jansen H, Shrewsbury VA, O'Malley C, Stolk RP, et al. Interventions for treating obesity in children. *Cochrane database of systematic reviews (Online)*. 2009(1):CD001872.
10. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, et al. Interventions for preventing obesity in children. *Cochrane database of systematic reviews (Online)*. 2011(12):CD001871.
11. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.
12. van Grieken A, Veldhuis L, Renders CM, Borsboom GJ, van der Wouden JC, Hirasing RA, Raat H. Population-based childhood overweight prevention: outcomes of the 'Be active, eat right' study. *PloS one*. 2013;8(5):e65376.
13. van Grieken A. Thesis: "Promotion of a healthy weight and lifestyle among children: The 'Be active, eat right' study. Chapter 3: Promotion of a healthy lifestyle among 5-year-old overweight children: health behavior outcomes of the 'Be active, eat right' study." Rotterdam: Erasmus University Rotterdam 2013.
14. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA, van Buuren S. Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PloS one*. 2011;6(11):e27608.
15. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed*. 2000;320(7244):1240-1243.
16. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Signaleringsprotocol Overgewicht in de Jeugdgezondheidszorg [Youth Health Care Overweight-detection-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; November 2004.
17. Renders CM, Halberstadt J, Frenkel CS, Rosenmoller P, Seidell JC, Hirasing RA. Tackling the problem of overweight and obesity: the dutch approach. *Obesity facts*. 2010;3(4):267-272.

18. van de Laar CWE, Renders CM, Dijkman MAM, HiraSing RA. Aanpak overgewicht in de Jeugdgezondheidszorg. De ontwikkeling en evaluatie van een Minimal Interventie Strategie bij kinderen van groep 2 uit het basisonderwijs. [Tackling overweight in Youth Healthcare. The development and evaluation of a Minimal Intervention Strategy among children at the start of elementary school]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Centre; 2006.
19. Brug J, Oenema A, Ferreira I. Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *Int J Behav Nutr Phys Act*. 2005;2(1):2.
20. Swinburn BA, de Silva-Sanigorski AM. Where to from here for preventing childhood obesity: an international perspective. *Obesity (Silver Spring, Md*. 2010;18 Suppl 1:S4-7.

2

‘Be active, eat right’, evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomized controlled trial

Lydian Veldhuis
Mirjam K. Struijk
Willemieke Kroeze
Anke Oenema
Carry M. Renders
Anneke M.W. Bulk-Bunschoten
Remy A. HiraSing
Hein Raat

BMC Public Health. 2009;9:177

ABSTRACT

Background

The prevalence of overweight and obesity in children has at least doubled in the past 25 years with a major impact on health. In 2005 a prevention protocol was developed applicable within Youth Health Care. This study aims to assess the effects of this protocol on prevalence of overweight and health behavior among children.

Methods and design

A cluster randomized controlled trial is conducted among 5-year-old children included by 44 Youth Health Care teams randomized within 9 Municipal Health Services. The teams are randomly allocated to the intervention or control group. The teams measure the weight and height of all children. When a child in the intervention group is detected with overweight according to the international age and gender specific cut-off points of BMI, the prevention protocol is applied. According to this protocol parents of overweight children are invited for up to three counseling sessions during which they receive personal advice about a healthy lifestyle, and are motivated for and assisted in behavioral change.

The primary outcome measures are Body Mass Index and waist circumference of the children. Parents will complete questionnaires to assess secondary outcome measures: levels of overweight inducing/reducing behaviors (i.e. being physically active, having breakfast, drinking sweet beverages and watching television/playing computer games), parenting styles, parenting practices, and attitudes of parents regarding these behaviors, health-related quality of life of the children, and possible negative side effects of the prevention protocol. Data will be collected at baseline (when the children are aged 5 years), and after 12 and 24 months of follow-up. Additionally, a process and a cost-effectiveness evaluation will be conducted.

Discussion

In this study called 'Be active, eat right' we evaluate an overweight prevention protocol for use in the setting of Youth Health Care. It is hypothesized that the use of this protocol will result in a healthier lifestyle of the children and an improved BMI and waist circumference.

Trial registration

Current Controlled Trials ISRCTN04965410

BACKGROUND

Childhood overweight and obesity

The prevalence of overweight and obesity among children has at least doubled over the past 25 years, especially in socially disadvantaged and specific ethnic subgroups.[1-6] In the Netherlands, in 2003 the prevalence of overweight (obesity included) among boys and girls aged about 5 years was 12.8% and 17.5%, respectively, compared with 5.2% and 8.6%, respectively, in 1980.[7]

Adverse health effects of obesity in children are: type 2 diabetes, hypertension, high cholesterol levels, apnea during sleep, psychosocial problems and a lower quality of life.[8-12] Being overweight or obese as a child increases the risk of becoming an overweight or obese adult,[13] and is associated with increased morbidity and mortality.[13-17] Therefore, prevention of childhood overweight and obesity is important. To prevent and curtail the increase of overweight and obesity in children, evidence-based prevention programs are needed.

Preventing childhood overweight and obesity

Studies have suggested that the methods for prevention of overweight and obesity in childhood are family-based intervention programs that include personal advice about a healthy lifestyle and counseling behavioral changes. Such programs should focus on a combination of inducing healthy nutritional behavior (i.e. having family breakfast daily and reducing intake of sweet beverages) and reducing sedentary behavior (i.e. inducing being physically active and reducing watching TV/playing computer games).[18-21] The parents' role is of particular importance for the behavior of children, especially among young children. Parents directly determine the physical and social environment of children, and indirectly influence behavior and habits through socialization processes and modelling.[22, 23] It is also recommended that more attention should be given to long-term sustainability and incorporating of interventions in daily practice.[20]

The Netherlands has a unique system for the maintenance of the health of children, i.e. the Youth Health Care (YHC) system. All children (0-19 years) are monitored by a nation-wide program at set ages. This program is offered free of charge by the government; participation is voluntary. The attendance rate is 95%. During the YHC check-ups the growth of each child is measured.[24] In 2005 a consensus-based protocol was developed to be applied in the YHC setting for the prevention of overweight and obesity in children aged 0 to 19 years.[25] The Municipal Health Services (MHSs) are preparing the implementation of this prevention protocol; however, before wide-scale implementation an effect evaluation of the protocol is needed.

Objectives

The first YHC check-up during school age is at 5-6 years: an important moment to consider the prevention of overweight. The aim of the study 'Be active, eat right' is to assess the effectiveness of the prevention protocol among children with overweight. The design of the study is described below.

The study hypotheses

The hypotheses of the study are that, after two years of follow-up, compared with the control group the overweight children in the intervention group will:

- have reduced BMI and waist circumference
- more frequently have family breakfast on a daily basis, and consume less sweet beverages
- spend more time being physically active and less time watching television/playing computer games

We apply a cluster design with YHC teams (physician, nurse and assistant) as the unit of randomization. Randomization at the individual level (i.e. the level of the children) may lead to contamination of the control group.[26] The outcome measures of the study (BMI, waist circumference, and levels of inducing/reducing overweight behaviors) are performed at the individual level. The follow-up measures will be compared between the intervention and control group, taking into account the baseline values.

METHODS AND DESIGN

Study design

This cluster randomized controlled trial is conducted in the Netherlands among children aged about 5 years and their parents, who are invited by the MHSs for a regular preventive health check. The YHC teams that perform the check consist of a physician, a nurse and an assistant; they form the unit of randomization. The randomization code was developed using a computer random number generator in SPSS to select random permuted blocks (specified allocation ratio 1:1). The block lengths were 4 or 6, depending on the number of YHC teams that participate per MHS. Within the MHSs an even number of YHC teams were randomly allocated to the two study arms: an intervention and a control group. The teams in the intervention group offer the prevention protocol to parents of overweight children, and in the control group the teams offer usual care to these parents. The effects of the prevention protocol will be evaluated after two years of follow-up by comparing the outcomes of BMI and waist circumference of the overweight children with those of the children in the control

group, taking into account the baseline values of these measures.[20, 27] Data collection started in September 2007 and will continue until August 2010. The Medical Ethics Committee of the Erasmus Medical Centre Rotterdam approved the study protocol (reference number MEC-2007-163).

Study procedure

A few weeks before the regular preventive health check is scheduled, all parents receive information about the study 'Be active, eat right' at home by mail and are invited to provide written informed consent for participation in the study. In addition, all parents are invited to complete a two-page questionnaire to measure data on demographic factors, overweight inducing/reducing behaviors (i.e. being physically active, having breakfast, drinking sweet beverages and watching television/playing computer games), their attitudes regarding these behaviors, and the health-related quality of life of their children. With this information a non-response analysis can be performed.

During the preventive health check, the YHC teams register the measures of weight, height and waist circumference of the children, calculate the BMI, and classify all children as normal weight, overweight or obese according to the international age and gender specific cut-off points of BMI.[27] In the control group whenever a YHC team detects a child with overweight, they apply usual care. In general, this implies giving basic information to the parents during the regular preventive health check about the importance of good nutrition and physical activity.

In the intervention group, the subgroup of parents of overweight children are offered up to three additional structured lifestyle counseling sessions, according to the prevention protocol. During these sessions the focus is on four behaviors, i.e. being physically active, having breakfast, drinking sweet beverages, and watching television/playing computer games.[28] These particular behaviors were chosen based on a literature review reporting on the most promising elements to prevent overweight.[25] During the counseling sessions, parents receive personal advice about a healthy lifestyle and are motivated for and assisted in behavioral change.

At the end of the regular preventive health check, the subgroup of parents with overweight children (in both groups) is invited to complete an additional questionnaire. This questionnaire provides more specific data about the baseline levels of overweight inducing/reducing behaviors, attitudes of parents regarding these behaviors, and the health-related quality of life of the children.

Participants

Municipal Health Services and Youth Health Care teams

The managers of the MHSs, managers of the YHC department, and managers of the department of health education of all 37 MHSs in the Netherlands were informed about the study by mail and were contacted by the researchers by telephone in the first half of 2007. From the 37 MHSs, 9 volunteered to participate in the study. Of the remaining MHSs, 3 did not meet the inclusion criteria (i.e. MHSs should have YHC teams that had not used the prevention protocol before), 25 MHSs had other reasons not to participate (e.g. a recent or upcoming merger of MHSs). Of the 9 participating MHSs, a total of 44 YHC teams were willing to participate in the study. When a professional worked in more than one YHC team, the team that invited the most children for the health check during the school year 2007/2008 was selected for participation, and the other team was excluded from participation. At the start of the study no major changes were expected in the composition of the participating teams. The participating teams cover both urban and rural regions in the Netherlands. Prior to the start of the study, the research group arranged meetings to explain the procedure of the study and to instruct the participating YHC professionals.

Children and their parents

The study population consists of the subgroup of children with overweight according to the international age and gender specific cut-off points for BMI. Parents and children will be excluded from analysis if the children have chronic health problems that may influence the outcome measures. In order to participate the parents should have at least basic Dutch language skills. The study design and participant flow are shown in Figures 2.1 and 2.2.

Intervention

The prevention protocol (see appendix) is based on theories and models of behavioral change, i.e. the ASE model, a theoretical model of exercise habit formation, the Precaution Adoption Process Model, the Elaboration Likelihood Model, the stages of change model, and motivational interviewing techniques.[29-34] During the regular preventive health check, when a child in the intervention group with overweight is detected, the parents are offered up to three additional structured lifestyle counseling sessions to promote overweight-preventing behaviors. Prior to the start of the study, the YHC professionals in the intervention group received training in a non-directing guiding style as part of the prevention protocol.[35] The YHC professionals assess whether the parents are motivated to participate in this counseling, and will make use of a motivational interview approach if needed.[35] The three additional structured lifestyle counseling sessions are offered to parents with intervals of 1, 3 and 6 months after the regular preventive health check. The content of each visit depends on the stage of behavioral change that the parents are in.[33] The purpose of the sessions is to make

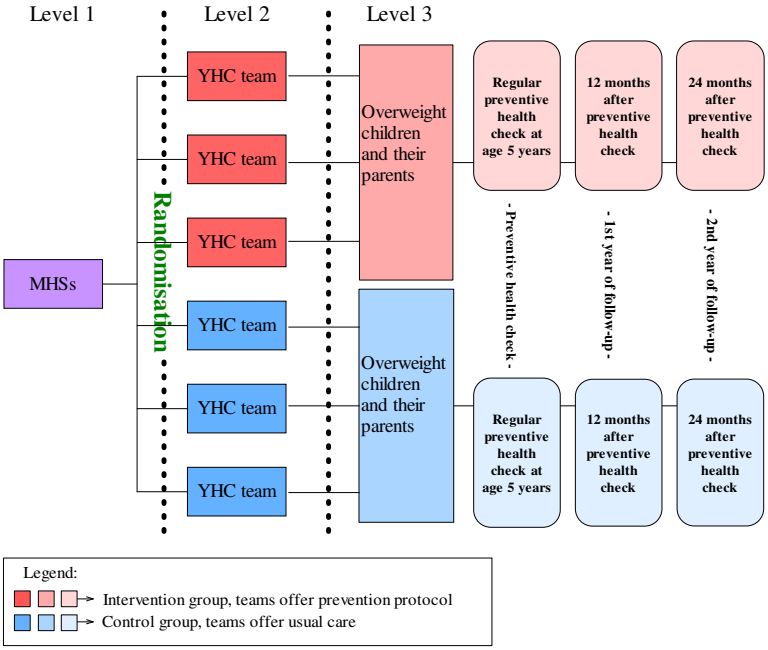

Figure 2.1 Flow chart of the design of the study

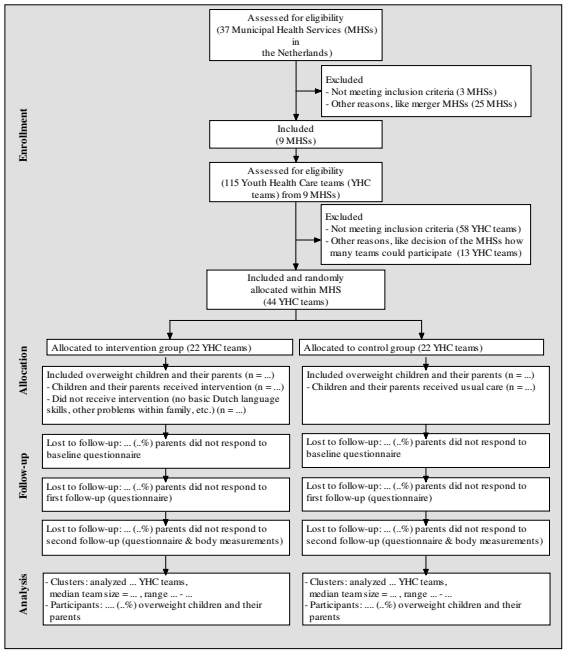

Figure 2.2 Flow of the clusters and participants through the trial

Table 2.1 Guidelines used during counseling sessions regarding the four target behaviors for children aged 5 years

Behavior	Guideline
Being physical active	- At least 1 hour each day - Moderate intensity (outdoor playing, walking, cycling or doing sport)
Having breakfast	- Daily - In the family setting
Drinking sweet beverages	- Not more than 2 glasses per day (of soft drinks, fruit juices, sports/ energy drinks, sweetened milk/yoghurt drinks or tea with sugar)
Watching television/ playing computer games	- Not more than 2 hours per day (watching television and playing computer games combined)

parents aware of the overweight of their child, to provide information about overweight and its consequences, and to motivate the parents for and assist them in behavioral change. Materials that are used during the sessions are: a form for the YHC professional to assess the behaviors that should be targeted within the family, and diaries on energy intake and expenditure to be completed by the parents. Table 2.1 shows the guidelines for the four target behaviors for children at the age of about 5 years. The YHC professional and the parents together draw up a family-oriented action plan aiming at the promotion of physical activity and outdoor playing time, having family breakfast daily, consuming less sweet drinks and/ or limiting watching television/playing computer games (Appendix 2.1).[25] A pilot study has established the feasibility and acceptability of the prevention protocol.[36]

Measurements

Primary outcomes

Body measurements

Standardized methods are used to measure weight, height and waist circumference of all children. The YHC professionals received training in measuring the waist circumference of the children and all use the same type of measuring tape (SECA 200) provided by the researchers. BMI is calculated using weight in kilogram divided by squared height in meters. The YHC professionals received a calculator with instructions on how to calculate BMI. At baseline the YHC professionals classify the children into groups of normal weight, overweight or obese, according to the age and gender-specific cut-off points for BMI as published by the International Obesity Task Force (IOTF).[27, 37] After two years of follow-up the anthropometric measures will be repeated.

Secondary outcomes

Four target behaviors

In the questionnaire (2 pages) and the additional questionnaire booklet (including questions from SQUASH,[38] CHQ-PF28[39] and SDQ[40]) parents report (for weekdays and weekend days) the following:

- the frequency and duration of physical activity and outdoor playing time of their children
- how often their children have breakfast
- the intake of sweet beverages of their children
- the frequency and duration of inactivity of their children due to watching television and/or playing computer games

Data on parenting styles, parenting practices and attitude of the parents concerning the four target behaviors are assessed. Examples are: behavior of the parents themselves, family rules about watching television/playing computer games, and availability at home of sweet beverages and breakfast products. After 12 and after 24 months of follow-up a questionnaire to assess this data will be repeated.

Other characteristics that will be taken into account include:

- demographics: gender, ethnicity of the children and parents, educational level of the parents, household and family composition, and neighborhood characteristics (i.e. can children play safely outside; presence of busy roads, etc.)
- self-reported weight and height of the parents themselves
- participation in weight-management programs other than those used in the present study
- general health of the children (measured with the 28-item Child Health Questionnaire (CHQ-PF28)[39]
- health-related quality of life, and emotional/behavioral problems of the children[40]
- indicators of negative side effects (i.e. worry, stigmatization and lower self-esteem related to the weight of the children, and development of relative underweight)[20]

Sample size

Sample size was calculated taking into account the intra-cluster correlation coefficient (ρ = 0.1), the number of clusters (44), the expected prevalence of overweight children in the study population, the standard deviation (SD), expected effect (a difference in mean), and the power of the study (80%). With a participation of 50%, an expected prevalence of overweight children of 9% and a loss-to-follow-up of 30%, at least 11,301 children (and their parents) should be invited by the YHC teams to participate in the study to have a final sample of

about 356 overweight children (178 in both the intervention and control group). Assuming a SD of BMI to be 1.0 kg/m^2,[36] a difference in mean BMI of 0.35 kg/m^2 between the children in the intervention group and the children in the control group can be established under the assumptions mentioned above. Assuming an SD of the average number of hours per day of watching TV, video, DVD and playing computer games combined to be 60 minutes per day,[36, 41, 42] a difference of 20 minutes per day can be established.

Statistical analysis

The aim of the study is to assess the effectiveness of the prevention protocol among children with overweight. An intention-to-treat analysis will be applied.[43] Multi-level analyses will be applied because of the three-level structure of the study, i.e. correlation of the repeated observations within a participant and the correlation of the observations of participants within a YHC team.[26, 44] Linear multilevel analysis will be applied for continuous outcome variables and logistic multilevel analysis for dichotomous outcome variables.[44] Biometric and behavioral outcomes of the children at age 7 years will be analyzed with independent variables: intervention or control group, gender, age, socio-economic status, ethnicity, weight of the parents, and baseline levels of the outcome variables. Interaction effects of gender, social disadvantage and ethnic background with the effect of the prevention protocol will be explored.

Process evaluation: non-response, adherence and cost-effectiveness

In addition to the effect evaluation a process evaluation will be carried out.

A non-response analysis will be conducted to determine possible selection bias. In the non-response analysis the following characteristics of (non)-participating children and their parents will be considered: ethnicity of the parents and children, educational level of the parents, household composition, an indication of the levels of the four target behaviors reported by the parents, and self-reported BMI of the parents and their children. For adherence to the prevention protocol the following variables are registered: classification of the children by the YHC professionals to the correct weight status according to the international age and gender specific cut-off points of BMI, the number of sessions the parents of overweight children attend, and the intensity of the sessions (i.e. did the parents complete energy intake and/or expenditure diaries, draw up a family-oriented action plan with the YHC professional, etc.). Adherence of both the YHC professionals and parents to the different elements of the prevention protocol will be analyzed in relation to changes in BMI, waist circumference, and lifestyle of the children by multiple linear or logistic regression analysis (depending on the type of outcome variable). Analysis of these variables may indicate which elements of the prevention protocol work (or do not work), and for whom. In addition, satisfaction with the

protocol of parents and YHC professionals will also be assessed. Finally, a cost-effectiveness analysis will be performed using a societal perspective, including program and parents costs.

DISCUSSION

This study presents the design of a cluster randomized controlled trial on the prevention of overweight and obesity in children. The study evaluates a protocol that is proposed for application in the YHC setting for the prevention of overweight and obesity in children.

It is hypothesized that, after two years of follow-up, overweight children in the intervention group will have less BMI and waist circumference, spend more time being physically active, more frequently have family breakfast on a daily basis, consume less sweet beverages, and spend less time watching television/playing computer games compared to overweight children in the control group. Differences between subgroups (ethnicity and socio-economic status) regarding the effects of the prevention protocol, and determinants of overweight and obesity, will be described. Several process variables will be registered to measure whether differences exist in subgroups of adherence to the prevention protocol, concerning the positive effects on BMI, waist circumference and lifestyle. This will also provide insight into the effective elements of the prevention protocol.

Strengths of the study are the size of the study (44 YHC teams), the random controlled design, and the regular preventive health check of the MHSs which more than 95% of all invited parents and their children attend.[45] Children receive a YHC check-up at set ages, which offers optimal opportunity to provide tailored prevention. The follow-up at 12 and 24 months allow to investigate the long-term effects of the prevention protocol. Regarding the generalisability of the study results, a first strength is that it is a controlled study conducted in the practice setting. The intervention is applicable in the daily practice of the YHC professionals, which will facilitate implementation of the prevention protocol if it is found to be effective. A second strength regarding generalisability is that the participating YHC teams cover both urban and rural areas. A limitation of the study is that the behavior of the children and their parents is based on self-reports by the parents.

In conclusion, this study evaluates a protocol for the prevention of overweight and obesity in children. The results of this study will provide insight into the effectiveness of the prevention protocol used in Youth Health Care, and in the determinants of overweight and obesity of children aged 5 to 7 years.

REFERENCES

1. Whitlock EP, Williams SB, Gold R, Smith PR, Shipman SA. Screening and interventions for childhood overweight: a summary of evidence for the US Preventive Services Task Force. *Pediatrics*. 2005;116(1):e125-144.
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
3. Fredriks AM, van Buuren S, Burgmeijer RJ, Meulmeester JF, Beuker RJ, Brugman E, et al. Continuing positive secular growth change in The Netherlands 1955-1997. *Pediatric research*. 2000a;47(3):316-323.
4. Fredriks AM, van Buuren S, Wit JM, Verloove-Vanhorick SP. Body index measurements in 1996-7 compared with 1980. *Archives of disease in childhood*. 2000b;82(2):107-112.
5. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr*. 2005;94(4):496-498.
6. Hirasing RA, Fredriks AM, van Buuren S, Verloove-Vanhorick SP, Wit JM. [Increased prevalence of overweight and obesity in Dutch children, and the detection of overweight and obesity using international criteria and new reference diagrams]. *Nederlands tijdschrift voor geneeskunde*. 2001;145(27):1303-1308.
7. van den Hurk K, van Dommelen P, van Buuren S, Verkerk PH, Hirasing RA. Prevalence of overweight and obesity in the Netherlands in 2003 compared to 1980 and 1997. *Archives of disease in childhood*. 2007;92(11):992-995.
8. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. [Youth Health Care Overweight-detection-protocol]. Woerden: Platform Jeugdgezondheidszorg; 2005.
9. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics*. 1998;101(3 Pt 2):518-525.
10. Must A, Strauss RS. Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord*. 1999;23 Suppl 2:S2-11.
11. Wabitsch M. Overweight and obesity in European children: definition and diagnostic procedures, risk factors and consequences for later health outcome. *European journal of pediatrics*. 2000;159 Suppl 1:S8-13.
12. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, et al. Orthopedic complications of overweight in children and adolescents. *Pediatrics*. 2006;117(6):2167-2174.
13. Singh AS, Mulder C, Twisk JW, van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9(5):474-488.
14. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, et al. Health consequences of obesity. *Archives of disease in childhood*. 2003;88(9):748-752.
15. Must A. Does overweight in childhood have an impact on adult health? *Nutrition reviews*. 2003;61(4):139-142.
16. Maffeis C, Tato L. Long-term effects of childhood obesity on morbidity and mortality. *Hormone research*. 2001;55 Suppl 1:42-45.
17. Power C, Lake JK, Cole TJ. Measurement and long-term health risks of child and adolescent fatness. *Int J Obes Relat Metab Disord*. 1997;21(7):507-526.
18. Campbell K, Waters E, O'Meara S, Kelly S, Summerbell C. Interventions for preventing obesity in children. *Cochrane database of systematic reviews (Online)*. 2002(2):CD001871.

19. Position of the American Dietetic Association: individual-, family-, school-, and community-based interventions for pediatric overweight. *Journal of the American Dietetic Association*. 2006;106(6):925-945.
20. Doak CM, Visscher TL, Renders CM, Seidell JC. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obes Rev*. 2006;7(1):111-136.
21. Kalavainen MP, Korppi MO, Nuutinen OM. Clinical efficacy of group-based treatment for childhood obesity compared with routinely given individual counseling. *International journal of obesity (2005)*. 2007;31(10):1500-1508.
22. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, et al. A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health education research*. 2007;22(2):203-226.
23. Ritchie LD, Welk G, Styne D, Gerstein DE, Crawford PB. Family environment and pediatric overweight: what is a parent to do? *Journal of the American Dietetic Association*. 2005;105(5 Suppl 1):S70-79.
24. Burgmeijer RJF, Van Geenhuizen YM, Filedt Kok-Weimar T, De Jager AM. *[On the road to adulthood. Evaluation School Health Care 1996]*. Leiden: TNO Preventie en Gezondheid/KPMG; 1997.
25. Hirasing RA, Bulk-Bunschoten AMW, Renders CM. [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Free University Medical Center; 2005.
26. Campbell MK, Elbourne DR, Altman DG. CONSORT statement: extension to cluster randomised trials. *BMJ (Clinical research ed*. 2004;328(7441):702-708.
27. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed*. 2000;320(7244):1240-1243.
28. Whitaker RC. Obesity prevention in pediatric primary care: four behaviors to target. *Archives of pediatrics & adolescent medicine*. 2003;157(8):725-727.
29. De Vries H, Mudde AN. Predicting stage transitions for smoking cessation applying the attitude-social influence-efficacy model. *Psychology & Health*. 1998;13(2):369-385.
30. Aarts H, Paulussen T, Schaalma H. Physical exercise habit: on the conceptualization and formation of habitual health behaviours. *Health education research*. 1997;12(3):363-374.
31. Weinstein ND, Sandman PM. A model of the precaution adoption process: evidence from home radon testing. *Health Psychol*. 1992;11(3):170-180.
32. Petty R, Cacioppo JT. The elaboration likelihood model of persuasion. *Advances in experimental social psychology*. 1986;19:123-205.
33. Prochaska JO, DiClemente CC. Stages of change in the modification of problem behaviors. *Progress in behavior modification*. 1992;28:183-218.
34. Miller WR, Rollnick S. *Motivational interviewing, preparing people to change.*: The Guilford Press, New York London; 2002.
35. Rollnick S, Butler CC, McCambridge J, Kinnersley P, Elwyn G, Resnicow K. Consultations about changing behaviour. *BMJ (Clinical research ed*. 2005;331(7522):961-963.
36. Van de Laar CWE, Renders CM, HiraSing RA. [Preventie van overgewicht: een minimale interventie strategie bij 5/6 jarige kinderen binnen de JGZ. Presentatie bij. In: NWO-werkgemeenschap Jeugd&Gezondheid; 2006 20-21 januari]; Soesterberg; 2006.
37. Must A, Anderson SE. Body mass index in children and adolescents: considerations for population-based applications. *International journal of obesity (2005)*. 2006;30(4):590-594.
38. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *J Clin Epidemiol*. 2003;56(12):1163-1169.

39. Raat H, Botterweck AM, Landgraf JM, Hoogeveen WC, Essink-Bot ML. Reliability and validity of the short form of the child health questionnaire for parents (CHQ-PF28) in large random school based and general population samples. *Journal of epidemiology and community health*. 2005;59(1):75-82.
40. Goodman R. The Strengths and Difficulties Questionnaire: a research note. *J Child Psychol Psychiatry*. 1997;38(5):581-586.
41. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *Jama*. 1999;282(16):1561-1567.
42. Gortmaker SL, Peterson K, Wiecha J, Sobol AM, Dixit S, Fox MK, et al. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Archives of pediatrics & adolescent medicine*. 1999;153(4):409-418.
43. Hollis S, Campbell F. What is meant by intention to treat analysis? Survey of published randomised controlled trials. *BMJ (Clinical research ed.* 1999;319(7211):670-674.
44. Twisk JWR. *Applied Multilevel Analysis: A Practical Guide*. Cambridge: Cambridge University Press; 2006.
45. CBO. *Guideline Diagnosis and Treatment of Obesity in Adults and Children*. Utrecht; 2007. Available at: http://www.cbo.nl.

APPENDIX

Appendix 2.1 Description of the intervention: the different elements of the prevention protocol

- The YHC professional classifies children as normal weight, overweight or obese during the regular preventive health check
- The YHC professional offers parents of overweight children up to three additional lifestyle counseling sessions
- The YHC professional assesses whether the parents are motivated to participate
- The YHC professional will use the motivational interview approach if necessary
- The YHC professional assesses the behavior(s) that should be targeted
- The YHC professional gives health-promoting and personal advice to the parents
- The YHC professional motivates parents for behavioral change
- The YHC professional and parents together draw up an action plan
- Parents complete diaries on energy intake and expenditure
- Intervals of the counseling sessions: 1 month, 3 months and 6 months

3

Moderate agreement between body mass index and measures of waist circumference in the identification of overweight among 5-year-old children; the 'Be active, eat right' study

Lydian Veldhuis
Ineke Vogel
Wilma Jansen
Carry M. Renders
Remy A. HiraSing
Hein Raat

BMC Pediatr. 2013;13:63

ABSTRACT

Background

Body mass index (BMI) is a common indirect method to assess weight status among children. There is evidence that BMI data alone can underestimate overweight-related health risk and that waist circumference (WC) should also be measured. In this study we investigated the agreement between BMI and WC and BMI and the waist-height ratio (WHtR) when used to identify overweight among children.

Methods

This cross-sectional population-based study uses baseline data from 5-year-olds (n = 7703) collected by healthcare professionals for the 'Be active, eat right' study.

Results

According to age-specific and sex-specific cut-off points for BMI (IOTF, 2000) and WC (Fredriks et al., 2005), the prevalence of overweight (obesity included) was 7.0% and 7.1% among boys, and 11.6% and 10.1% among girls, respectively. For the WHtR the 90th percentile was used as the cut-off point. Among boys, observed proportion of agreement between BMI and WC classification was 0.95, Cohen's kappa 0.58 (95% CI; 0.53-0.63), and proportions of positive and negative agreement were 0.61 and 0.97, respectively. Observed proportion of agreement between BMI and WHtR classification was 0.92, Cohen's kappa 0.46 (95% CI; 0.41-0.51), and proportions of positive and negative agreement were 0.51 and 0.95. Children identified as overweight according to WC were relatively tall, and children classified as overweight according to the WHtR only were relatively short (comparable results for girls).

Conclusions

There is moderate agreement between BMI and measures of WC on the presence of overweight among 5-year-olds. If BMI data and cut-offs continue to be used, then part of the group of children identified as overweight according to WC and the WHtR will be omitted. Follow-up of the children classified as overweight according to BMI only, WC only, and WHtR only, will give indications whether WC should be measured in addition to BMI or whether WC should only be measured in certain subgroups (e.g. relatively tall or short children) to identify and monitor overweight in children. This may improve early identification and prevention of overweight and overweight-related health problems in children.

BACKGROUND

The prevalence of overweight and obesity among children has increased rapidly worldwide.[1, 2] The common indirect method of identifying overweight among children is use of the body mass index (BMI).[3-6] However, it has been indicated that only using BMI data results in an underestimation of health risk, as BMI is an indicator of excess weight relative to height and does not indicate body fat distribution.[7] Waist circumference (WC) is a marker of central fat distribution, and there is considerable evidence that high central fat distribution is associated with an increased risk of metabolic complications, such as insulin resistance, in both adults and children.[8-11] There is, however, at this moment neither international consensus on whether WC should be used in conjunction with BMI to identify overweight among children[1, 6, 12, 13] nor whether WC should be measured as part of a ratio (e.g. waist-height ratio (WHtR)).[11, 12, 14-17]

In the Netherlands, all children are monitored in a nationwide program at set ages. This is a free service and attendance rate for these well-child visits is 95%. During these regular check-ups, healthcare professionals measure the height and weight of each child.[18] The healthcare professionals also assess whether a child has overweight. They base their decision on the child's BMI and their clinical judgment by taking into account the child's stature, ethnicity, and body-fat distribution.[19] However, this clinical judgment is based on the knowledge and experience of the professional and the process can not be standardized and remains arbitrary. A possibility to make the decision less arbitrary is to also measure WC.[19] The question that arises is whether WC should be measured in addition to BMI in monitoring programs to identify all children at increased risk for overweight-related health problems. A first step is to investigate whether BMI and WC agree about children's weight status. And when BMI and WC disagree about weight status, it is important to have insight in the characteristics of the children not identified as overweight when using only BMI.

We compared BMI versus WC and BMI versus the WHtR in a large population-based sample of 5-year-old children to establish 1) whether BMI and WC agree on weight status of these young children, whether BMI and the WHtR agree on these children's weight status, and 2) whether there are differences in children's characteristics (ethnic background, weight, height) between the groups that are overweight according to BMI or WC, and between the groups that are overweight according to BMI or the WHtR. We also examined the clinical judgment of the healthcare professional on the children's weight status in the groups that are overweight according to BMI, WC or the WHtR.

METHODS

Design and study population

The present cross-sectional study is embedded in the 'Be active, eat right' study, which aims to assess the effects of an overweight prevention protocol as detailed elsewhere.[20] The Medical Ethics Committee of Erasmus MC University Medical Centre Rotterdam approved the study protocol. Nine of the 37 municipal health services in the Netherlands participated in the 'Be active, eat right' study. A total of 13,638 parents of 5-year-olds were invited by mail for a well-child visit at one of the nine municipal health services. These parents were also invited to participate in the 'Be active, eat right' study and 64.4% provided written informed consent to participate in the study. Baseline data were collected during the 2007–2008 school year, and these data were used for the present study.

Children were excluded from analyses when data were missing on anthropometric measurements (n = 475), on age or sex (n = 98), on weight status according to the clinical judgment of the healthcare professional during the well-child visit (n = 381), on parental educational level (as an indicator of socioeconomic status) or ethnicity (n = 127). After exclusion, a study population of n = 7703 remained.

Anthropometry, weight status and characteristics

During well-child visits trained healthcare professionals of the municipal health services measured each child's body weight, height and WC using standardized methods as described in a protocol.[19] Body weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm. WC was measured over naked skin midway between the lower rib margin and the iliac crest at the end of gentle expiration while the children were in standing position.[19] The healthcare professionals were trained to measure WC using a measuring tape (type of measuring tape; SECA 200).

BMI was calculated by dividing weight (in kilograms) by height (in meters) squared. The weight status of the children according to BMI was assessed using the International Obesity Task Force's (IOTF) age-specific and sex-specific cut-off points.[21] To assess the weight status of the children according to WC data, we used the age and sex specific cut-off points for Dutch children as presented by Fredriks et al.[22] When a child's BMI or WC value was the same as or higher than the lower-bound cut-off point for overweight for the child's age and sex, the child was classified as overweight (obesity included).

For the WHtR, no internationally accepted cut-off points are available. We used the 90th percentile within our total study population at baseline (n = 8784) as the lower-bound cut-off point for having overweight (obesity included). The healthcare professionals reported their

clinical judgment on the weight status of the children. This judgment was based on the child's stature, ethnicity and body-fat distribution.[19, 23, 24]

We obtained information about the child's age, sex, ethnic background, and parental educational level from a questionnaire completed by the parents. A child was considered to be of non-Dutch ethnic background when at least one of the parents was born abroad (according to the definition of Statistics Netherlands).[25] Educational level of the parents was recoded in three categories according to the Dutch standard classification as defined by Statistics Netherlands:[26] high level (academic higher education/university education, higher professional education), mid level (pre-university education, senior general secondary education, and senior secondary vocational education), and low level (preparatory secondary vocational education, lower secondary vocational education, primary education, and no education).

Statistical analyses

Mean and frequency differences between boys' and girls' characteristics were examined using independent-samples t tests for continuous variables and Chi-square statistics for categorical variables. Children were categorized into subgroups according to which measures identified them as overweight ('overweight BMI and WC', 'overweight BMI and WHtR', 'overweight BMI only', 'overweight WC only', 'overweight WHtR only') or which measures identified them as not overweight ('not overweight BMI and WC' and 'not overweight BMI and WHtR').

Mean and frequency differences were examined using analyses of variance (ANOVA) and Chi-square statistics to explore potential differences between the subgroups with regards to 1) children's characteristics and 2) the healthcare professional's clinical judgment on the weight status of the child. For all analyses examining differences between subgroups, a p-value < 0.05 was considered to be statistically significant. Agreement between BMI and WC and between BMI and the WHtR on the prevalence of overweight (obesity included) was investigated by cross-tabulation and expressed as observed proportion of agreement and Cohen's kappa.[27, 28] We regarded neither BMI, nor WC or WHtR as the 'gold standard'. As we observed the paradox of a low kappa value and relatively high observed proportion of agreement, which is the result of the imbalance in the distribution of the marginal totals in the cross-table, we calculated a positive agreement index and a negative agreement index in addition to Cohen's kappa (see Appendix 3.1 for calculations).[29, 30] Statistical analyses were performed using the SPSS program (version 15; SPSS Inc, Chicago, USA).

RESULTS

Among boys (n = 3895), the prevalence of overweight according to BMI cut-off points[21] was 7.0% (n = 272) and according to WC cut-off points[22] was 7.1% (n = 277) (Table 3.1 and Table 3.2). Of all boys, 4.3% (n = 168) were overweight according to both BMI and WC cut-off points, 4.3% (n = 168) were overweight according to both BMI and WHtR, 2.7% (n = 104) were overweight according to BMI only, 2.8% (n = 109) were overweight according to WC only, and 5.8% (n = 224) were overweight according to WHtR only (Table 3.2 and Table 3.4). In the subgroup of boys classified as overweight according to both BMI and WC (n = 168), 88.1% (n = 148) were also classified as overweight according to the clinical judgment of the healthcare professional. In the subgroup overweight BMI only (n = 104) and in the subgroup WC only (n = 109), respectively 66.3% (n = 69) and 16.5% (n = 18) of the children were also classified as overweight according to the clinical judgment of the healthcare professional (Table 3.1). In the subgroup classified as overweight according to both BMI and the WHtR (n = 168), 85.7% (n = 144) were also classified as overweight according to the clinical judgment of the healthcare professional. In the subgroup overweight BMI only (n = 104) and in the subgroup WHtR only (n = 224), respectively 70.2% (n = 73) and 7.6% (n = 17) of the children were also classified as overweight according to the clinical judgment of the healthcare professional (Table 3.3). The observed proportion of agreement between BMI and WC was 0.95, kappa was 0.58 (95% CI; 0.53-0.63), the observed proportion of positive agreement was 0.61, and the proportion of negative agreement was 0.97. The observed proportion of agreement between BMI and

Table 3.1 Characteristics of the study population and subgroups classified as overweight (obesity included) according to BMI, WC or both (n = 7703)

	Boys					
	Total (n = 3895)	**Overweight BMI and WC (n = 168)**	**Overweight BMI only (n = 104)**	**Overweight WC only (n = 109)**	**Not-overweight BMI and WC (n = 3514)**	***p*-value**
Mean age, years (SD)	5.8 (0.4)	5.8 (0.4)	5.7 (0.5)	5.7 (0.4)	5.8 (0.4)	0.026[a]
Mean height, cm (SD)	117.8 (5.5)	122.1 (5.6)	117.8 (5.9)	121.5 (5.2)	117.5 (5.4)	0.000[b]
Mean weight, kg (SD)	21.6 (3.1)	28.9 (3.9)	25.3 (2.8)	24.5 (2.4)	21.0 (2.5)	0.000[c]
Mean BMI, kg/(m)^2 (SD)	15.5 (1.4)	19.3 (1.5)	18.1 (0.9)	16.5 (0.7)	15.2 (1.0)	0.000[d]
Mean WC, cm (SD)	53.4 (3.7)	63.3 (4.3)	55.9 (2.2)	59.8 (1.5)	52.6 (2.8)	0.000[d]
Non-Dutch ethnicity, n (%)	568 (14.6)	44 (26.2)	30 (28.8)	16 (14.7)	478 (13.6)	0.000[e]
Parental educational level low, n (%)	845 (21.7)	60 (35.7)	33 (31.7)	25 (22.9)	727 (20.7)	0.000[f]
Overweight according to clinical judgment of healthcare professional, n (%)	259 (6.6)	148 (88.1)	69 (66.3)	18 (16.5)	24 (0.7)	0.000[d]

Table 3.1 *(Continued)*

	Girls					
	Total (n = 3808)	**Overweight BMI and WC (n = 258)**	**Overweight BMI only (n = 183)**	**Overweight WC only (n = 128)**	**Not-overweight BMI and WC (n = 3239)**	***p*-value**
Mean age, years (SD)	5.7 (0.4)*	5.8 (0.4)	5.7 (0.4)	5.8 (0.4)	5.7 (0.4)	0.751
Mean height, cm (SD)	117.0 (5.6)**	120.8 (5.7)	117.7 (5.5)	120.5 (5.2)	116.5 (5.5)	0.000[g]
Mean weight, kg (SD)	21.3 (3.4)**	27.9 (3.6)	24.9 (2.5)	23.8 (2.5)	20.5 (2.5)	0.000[h]
Mean BMI, kg/(m)^2 (SD)	15.5 (1.6)	19.0 (1.5)	17.9 (0.8)	16.3 (0.9)	15.0 (1.1)	0.000[d]
Mean WC, cm (SD)	53.2 (4.1)*	62.4 (4.0)	55.7 (1.8)	59.9 (1.8)	52.1 (2.8)	0.000[d]
Non-Dutch ethnicity, n (%)	586 (15.4)	57 (22.1)	33 (18.0)	24 (18.8)	472 (14.6)	0.005[i]
Parental educational level low, n (%)	842 (22.1)	91 (35.3)	54 (29.5)	30 (23.4)	667 (20.6)	0.000[j]
Overweight according to clinical judgment of healthcare professional, n (%)	387 (10.2)**	233 (90.3)	113 (61.7)	16 (12.5)	25 (0.8)	0.000[d]

BMI = body mass index; WC = waist circumference. * $p < 0.05$ for difference between boys and girls. ** $p < 0.001$ for difference between boys and girls. Post-Hoc Tests (Tukey HSD for continuous determinants and cross-tabulation (2x2) for dichotomous determinants):
A = difference between 'overweight BMI and WC' and 'BMI only'.
B = difference between 'overweight BMI and WC' and 'WC only'.
C = difference between 'overweight BMI and WC' and 'not-overweight BMI and WC'.
D = difference between 'BMI only' and 'WC only'.
E = difference between 'BMI only' and 'not-overweight BMI and WC'.
F = difference between 'WC only' and 'not-overweight BMI and WC'.
[a] $p < 0.05$ for A and C.
[b] $p < 0.001$ for A, C, D and F.
[c] $p < 0.001$ for A, B, C, E, and F.
[d] $p < 0.001$ for A, B, C, D, E and F.
[e] $p < 0.05$ for B and D, $p < 0.001$ for C and E.
[f] $p < 0.05$ for B, D and F, $p < 0.01$ for E, $p < 0.001$ for C .
[g] $p < 0.05$ for E, $p < 0.001$ for A, C, D, and F.
[h] $p < 0.01$ for D, $p < 0.001$ for A, B, C, E and F.
[i] $p < 0.01$ for C.
[j] $p < 0.05$ for E, $p < 0.001$ for C.

Table 3.2 Comparison of weight status (not overweight/overweight, obesity included) according to BMI and WC cut-off points (n = 7703)

		Boys (n = 3895)			**Girls (n = 3808)**		
		BMI			**BMI**		
		Overweight	**Not overweight**	**Total**	**Overweight**	**Not overweight**	**Total**
WC	**Overweight**	168 (4.3%)	109 (2.8%)	277 (7.1%)	258 (6.8%)	128 (3.4%)	386 (10.1%)
	Not overweight	104 (2.7%)	3514 (90.2%)	3618 (92.9%)	183 (4.8%)	3239 (85.1%)	3422 (89.9)
	Total	272 (7.0%)	3623 (93.0%)	3895 (100%)	441 (11.6%)	3367 (88.4%)	3808 (100%)

BMI = body mass index; WC = waist circumference. Percentages presented are total percentages. Observed agreement: boys = 0.95; girls = 0.92. Cohen's kappa: boys = 0.58 (95% CI; 0.53 – 0.63); girls = 0.58 (95% CI; 0.54 -0.62). Positive agreement: boys = 0.61; girls = 0.62. Negative agreement: boys = 0.97; girls = 0.95. (See Appendix 3.1 for calculations.)

Table 3.3 Characteristics of the subgroups classified as overweight (obesity included) according to BMI, WHtR or both (n = 7703)

	Boys (n = 3895)				
	Overweight BMI and WHtR (n = 168)	**Overweight BMI only (n = 104)**	**Overweight WHtR only (n = 224)**	**Not-overweight BMI and WHtR (n = 3399)**	***p*-value**
Mean age, years (SD)	5.8 (0.5)	5.8 (0.4)	5.5 (0.4)	5.8 (0.4)	0.000[a]
Mean height, cm (SD)	119.8 (6.3)	121.6 (5.6)	113.3 (4.8)	117.9 (5.3)	0.000[b]
Mean weight, kg (SD)	27.9 (4.4)	27.0 (2.9)	21.0 (2.4)	21.1 (2.6)	0.000[c]
Mean BMI, kg/(m)^2 (SD)	19.3 (1.5)	18.2 (0.9)	16.3 (0.8)	15.2 (1.0)	0.000[d]
Mean WC, cm (SD)	62.6 (5.0)	57.1 (2.9)	56.7 (2.7)	52.6 (2.8)	0.000[e]
Non-Dutch ethnicity, n (%)	56 (33.3)	18 (17.3)	39 (17.4)	455 (13.4)	0.000[f]
Parental educational level low, n (%)	57 (33.9)	36 (34.6)	48 (21.4)	704 (20.7)	0.000[c]
Overweight according to clinical judgment of healthcare professional, n (%)	144 (85.7)	73 (70.2)	17 (7.6)	25 (0.7)	0.000[g]
	Girls (n = 3808)				
	Overweight BMI and WHtR (n = 216)	**Overweight BMI only (n = 225)**	**Overweight WHtR only (n = 169)**	**Not-overweight BMI and WHtR (n = 3198)**	***p*-value**
Mean age, years (SD)	5.7 (0.4)	5.8 (0.4)	5.6 (0.4)	5.7 (0.4)	0.001[h]
Mean height, cm (SD)	118.2 (5.6)	120.8 (5.7)	112.9 (5.6)	116.9 (5.4)	0.000[i]
Mean weight, kg (SD)	26.8 (3.9)	26.5 (3.2)	20.7 (2.7)	20.6 (2.6)	0.000[c]
Mean BMI, kg/(m)^2 (SD)	19.1 (1.6)	18.1 (0.8)	16.1 (0.9)	15.0 (1.1)	0.000[d]
Mean WC, cm (SD)	62.4 (4.6)	57.0 (2.7)	57.3 (3.1)	52.1 (2.9)	0.000[e]
Non-Dutch ethnicity, n (%)	50 (23.1)	40 (17.8)	31 (18.3)	465 (14.5)	0.003[j]
Parental educational level low, n (%)	74 (34.3)	71 (31.6)	40 (23.7)	657 (20.5)	0.000[k]
Overweight according to clinical judgment of healthcare professional, n (%)	197 (91.2)	149 (66.2)	14 (8.3)	27 (0.8)	0.000[d]

BMI = body mass index; WC = waist circumference; WHtR = waist-height ratio. Post-Hoc Tests (Tukey HSD for continuous determinants and cross-tabulation (2x2) for dichotomous determinants):

A = difference between 'overweight BMI and WHtR' and 'BMI only'.

B = difference between 'overweight BMI and WHtR' and 'WHtR only'.

C = difference between 'overweight BMI and WHtR' and 'not-overweight BMI and WHtR'.

D = difference between 'BMI only' and 'WHtR only'.

E = difference between 'BMI only' and 'not-overweight BMI and WHtR'.

F = difference between 'WHtR only' and 'not-overweight BMI and WHtR'.

[a] $p < 0.001$ for B, D, and F.

[b] $p < 0.05$ for A, $p < 0.001$ for B, C, D, E, and F.

[c] $p < 0.001$ for B, C, D, and E.

[d] $p < 0.001$ for A, B, C, D, E and F.

[e] $p < 0.001$ for A, B, C, E and F.

[f] $p < 0.05$ for A, $p < 0.01$ for C, $p < 0.001$ for B.

[g] $p < 0.01$ for A, $p < 0.001$ for B, C, D, E, and F.

[h] $p < 0.01$ for F, $p < 0.001$ for D.

[i] $p < 0.01$ for C, $p < 0.001$ for A, B, D, E, and F.

[j] $p < 0.001$ for C.

[k] $p < 0.05$ for B, $p < 0.01$ for E, $p < 0.001$ for C.

Table 3.4 Comparison of weight status (not overweight/overweight, obesity included) according to BMI and WHtR cut-off points (n = 7703)

		Boys (n = 3895)			Girls (n = 3808)		
		BMI			BMI		
		Overweight	Not overweight	Total	Overweight	Not overweight	Total
WHtR	Overweight	168 (4.3%)	224 (5.8%)	392 (10.1%)	216 (5.7%)	169 (4.4%)	385 (10.1%)
	Not overweight	104 (2.7%)	3399 (87.3%)	3503 (89.9%)	225 (5.9%)	3198 (84.0%)	3423 (89.9%)
	Total	272 (7.0%)	3623 (93.0%)	3895 (100%)	441 (11.6%)	3367 (88.4%)	3808 (100%)

BMI = body mass index; WHtR = waist-height ratio. Percentages presented are total percentages. Observed agreement: boys = 0.92; girls = 0.90. Cohen's kappa: boys = 0.46 (95% CI; 0.41 – 0.51); girls = 0.47 (95% CI; 0.42 -0.51). Positive agreement: boys = 0.51; girls = 0.52. Negative agreement: boys = 0.95; girls = 0.94. (See Appendix 3.1 for calculations.)

the WHtR was 0.92; kappa was 0.46 (95% CI; 0.41-0.51), the observed proportion of positive agreement was 0.51, and the proportion of negative agreement was 0.95.

Overall, results were similar for girls, but the prevalence of overweight was higher for girls compared to boys (according to BMI cut-off points the prevalence was 11.6% (n = 441) and according to WC cut-off points the prevalence was 10.1 % (n = 386)) (Table 3.1 and Table 3.2).

The subgroups of children classified as overweight according to both BMI and WC, BMI only or WC only differed in mean height, weight, BMI, WC, ethnic background, and parental educational level (Table 3.1). Compared to the other subgroups, children classified as overweight according to both BMI and WC were the tallest and heaviest and had the highest BMI and the largest WC. Further, children classified as overweight according to WC only were on average 3.0 cm taller than children classified as overweight according to BMI only (Table 3.1). The subgroups of children classified as overweight according to both BMI and WHtR, to BMI only or to WHtR only, also differed in mean height, weight, BMI, WC, ethnic background, and parental educational level (Table 3.3). These subgroups also differed in age; children classified as overweight according to WHtR only were relatively younger. Further, children classified as overweight according to WHtR only were relatively lighter in weight and shorter in height compared to other subgroups (Table 3.2).

DISCUSSION

We compared the assessment of overweight among 5-year-old children using BMI versus WC and BMI versus the WHtR. The results of the agreement analyses show that overall agreement between BMI classification versus WC and BMI classification versus the WHtR was high but the positive agreement between the measures was moderate to substantial. This indicated that BMI versus WC and BMI versus the WHtR agree moderately to substantially about the presence of overweight among 5-year-old children. It appeared that more than one third

of the total group of children classified as overweight according to BMI was not classified as overweight according to WC or the WHtR. This was the same in the group of children classified as overweight according to WC. In the group of children classified as overweight according to the WHtR, more than half of the total group was classified as overweight only according to the WHtR.

Compared to the overweight BMI only group, children classified as overweight according to WC only were relatively taller and more boys were of Dutch ethnic background. When comparing BMI to WHtR, children classified as overweight according to WHtR only were relatively younger, shorter, and lighter. Approximately 2 in 3 of the children classified as overweight according to BMI only were also clinically judged as overweight by a healthcare professional during a well-child visit. In the subgroup classified as overweight according to WC only, this ratio was approximately 1 in 7 and in the subgroup classified as overweight according to WHtR only, this ratio was approximately 1 in 12.

Our data comes from a large population-based study of young children. Because of the small age range, our results are specific to the 5-year-old age group. The weight status of the children according to BMI was assessed using the IOTF's age and sex specific cut-off points.[21] These cut-offs were chosen because they are used by the healthcare professionals at the municipal health services in the Netherlands.[19] By using these cut-off points, international comparisons of the prevalence of childhood overweight are also possible. Cut-off points for WC are not used in general by the healthcare professionals to assess children's weight status during well-child visits. Also, no international validated cut-off points for WC are available. We used the available age specific and sex specific cut-off points for WC for Dutch children as presented by Fredriks et al.[22] These cut-off points were based on data of 14,500 children aged 0–21 years in the Fourth Dutch Growth Study.[22] Internationally accepted cut-off points are also not available for the WHtR, and we used the 90th percentile within our total study population at baseline (n = 8784) as the cut-off point for classification of overweight (obesity included). We also investigated the agreement between BMI and WHtR classification by using the cut-off point of 0.5 for the WHtR[16, 17] instead of the 90th percentile, and results were similar.

As reported in previous studies, more girls were classified as overweight compared to boys in our study.[2, 13, 31, 32] As indicated in literature, a contribution to this may have been made by a significant difference in the sensitivity of the IOTF BMI cut-off points.[2, 4, 13] Children of parents with a low educational level, as an indicator of low socio-economic status,[33] and children of non-Dutch ethnic background[34] are at increased risk for overweight and this is also reflected in our results. A relatively large number of the children in our study population were of non-Dutch ethnic background (main ethnicities: Moroccan, Turkish, Surinamese and Dutch Antillean), which allowed us to investigate differences in the distribution of ethnic background

across the subgroups classified as overweight. The number of non-Dutch children was higher in the overweight subgroups but only among boys there was a statistically significant difference in ethnic background between the subgroups classified as overweight according to BMI only and WC only.

We compared the characteristics of the children in the study population with the characteristics of the children who were excluded from analyses due to missing data. Among boys, we found no statistically significant differences between those groups in age, height, weight, WC, ethnic background, parental educational level, or weight status of the children. Among girls, we found that weight, WC, and the prevalence of overweight according to BMI was higher among girls in the study population compared to girls who were excluded from analyses. However, we assume that the results of our analyses would be similar in the subgroup of girls with missing data.

Previous studies indicated that measuring only BMI results in an underestimation of health risk. To our knowledge, our study is the first study comparing classification results between BMI and WC and between BMI and the WHtR among 5-year-old children. The study by Fredriks et al.[22] found a strong correlation between BMI and WC. In additional analyses we also investigated the overall correlation in our study population, and we found comparable results. However, when we divided the BMI-group into quartiles, it appeared that the correlation was high only among children with a BMI in the highest quartile (see Appendix 3.2). So these findings indicate that BMI and WC merely agree among children with excess body fat in the highest percentile groups. This is also reflected in the results of the analyses in which we compared the children's characteristics between the overweight subgroups; the children classified as overweight according to both BMI and WC had the highest amount of overall body fat (as estimated by BMI) and abdominal fat (as estimated by WC).

Further, we found that children classified as overweight according to both BMI and WC, and according to WC only, appeared to be relatively taller than the group classified as overweight according to BMI only. On the other hand, when comparing BMI and the WHtR, we found that children classified as overweight according to BMI only were relatively tall, and children classified as overweight according to WHtR only were short. There could be several explanations for these findings. First, it has been suggested that BMI is a measure of excess weight relative to height and not of excess body fat.[14, 35] Therefore, BMI might not be a sensitive measure of body fat among children who are particularly short or tall or who have an unusual body fat distribution.[36] Second, children classified as overweight according to WC only might have a high WC as a consequence of being relatively tall for their age; this subgroup might include 'overall large children'. We recommend future studies to investigate whether the WHtR can be used to assess overweight among relatively short children. Specifically, future studies should

assess which cut-off points for WC or the WHtR are best to classify overweight among young children.

CONCLUSIONS

The results of our study show that, overall, the adiposity markers BMI versus WC and BMI versus the WHtR are only in moderate agreement on the presence of overweight among 5-year-olds. They agree on overweight status among these young children in the higher percentiles of the overweight group. However, when prevention of further increase of excess body fat is considered, children with levels of BMI and WC near the norm are particularly important. This group consisted of children with overweight according to BMI only, WC only, and WHtR only. If BMI cut-off points continue to be used by healthcare professionals as a basis for their assessment of overweight among young children in monitoring programs, then part of the children classified as overweight according to WC will be omitted. Even though this is a small percentage of the total population, it is a relatively large percentage of the group of children identified as overweight according to WC or WHtR. This group of children might also be at increased risk for overweight-related health problems.[8-11] Our results show that BMI might not be a sensitive marker among relatively tall or short children and that WC should be measured in addition to BMI among these children.

We recommend future studies to compare the subgroups of children identified as overweight according to BMI only, WC only, and WHtR only over time and to examine these children's risk of developing overweight-related health problems. It can then be decided whether WC should also be measured across the board in monitoring programs or only measured among certain subgroups such as relatively tall or short children. This will improve the identification and prevention of overweight and overweight-related health problems in children.

REFERENCES

1. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane database of systematic reviews (Online)*. 2005(3):CD001871.
2. Cattaneo A, Monasta L, Stamatakis E, Lioret S, Castetbon K, Frenken F, et al. Overweight and obesity in infants and pre-school children in the European Union: a review of existing data. *Obes Rev*. 2010;11(5):389-398.
3. World Health Organization. Factsheet Nº311, Obesity and overweight. Available from http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed March 2012: World Health Organization; February 2011.
4. Reilly JJ. Diagnostic accuracy of the BMI for age in paediatrics. *International journal of obesity (2005)*. 2006;30(4):595-597.
5. Krebs NF, Himes JH, Jacobson D, Nicklas TA, Guilday P, Styne D. Assessment of child and adolescent overweight and obesity. *Pediatrics*. 2007;120 Suppl 4:S193-228.
6. Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics*. 2009;124 Suppl 1:S3-22.
7. McCarthy HD, Ellis SM, Cole TJ. Central overweight and obesity in British youth aged 11-16 years: cross sectional surveys of waist circumference. *BMJ (Clinical research ed*. 2003;326(7390):624.
8. Freedman DS, Serdula MK, Srinivasan SR, Berenson GS. Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. *The American journal of clinical nutrition*. 1999;69(2):308-317.
9. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Body mass index, waist circumference, and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. *Pediatrics*. 2004;114(2):e198-205.
10. Janssen I, Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, et al. Combined influence of body mass index and waist circumference on coronary artery disease risk factors among children and adolescents. *Pediatrics*. 2005;115(6):1623-1630.
11. Maffeis C, Banzato C, Talamini G. Waist-to-height ratio, a useful index to identify high metabolic risk in overweight children. *The Journal of pediatrics*. 2008;152(2):207-213.
12. Horlick M, Hediger ML. Measurement matters. *The Journal of pediatrics*. 2010;156(2):178-179.
13. Reilly JJ, Kelly J, Wilson DC. Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. *Obes Rev*. 2010;11(9):645-655.
14. Must A, Anderson SE. Body mass index in children and adolescents: considerations for population-based applications. *International journal of obesity (2005)*. 2006;30(4):590-594.
15. Garnett SP, Baur LA, Cowell CT. Waist-to-height ratio: a simple option for determining excess central adiposity in young people. *International journal of obesity (2005)*. 2008;32(6):1028-1030.
16. Aeberli I, Gut-Knabenhans I, Kusche-Ammann RS, Molinari L, Zimmermann MB. Waist circumference and waist-to-height ratio percentiles in a nationally representative sample of 6-13 year old children in Switzerland. *Swiss medical weekly*. 2011;141:w13227.
17. Nambiar S, Truby H, Abbott RA, Davies PS. Validating the waist-height ratio and developing centiles for use amongst children and adolescents. *Acta Paediatr*. 2009;98(1):148-152.
18. Renders CM, Halberstadt J, Frenkel CS, Rosenmoller P, Seidell JC, Hirasing RA. Tackling the problem of overweight and obesity: the dutch approach. *Obesity facts*. 2010;3(4):267-272. Epub 2010 Aug
19. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. [Youth Health Care Overweight-detection-protocol]. Woerden: Platform Jeugdgezondheidszorg; 2005.

20. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, et al. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC public health*. 2009;9:177.
21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed*. 2000;320(7244):1240-1243.
22. Fredriks AM, van Buuren S, Fekkes M, Verloove-Vanhorick SP, Wit JM. Are age references for waist circumference, hip circumference and waist-hip ratio in Dutch children useful in clinical practice? *European journal of pediatrics*. 2005;164(4):216-222.
23. Daniels SR, Khoury PR, Morrison JA. The utility of body mass index as a measure of body fatness in children and adolescents: differences by race and gender. *Pediatrics*. 1997;99(6):804-807.
24. Bellizzi MC, Dietz WH. Workshop on childhood obesity: summary of the discussion. *The American journal of clinical nutrition*. 1999;70(1):173S-175S.
25. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. Den Haag/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
26. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Standaard Onderwijsindeling 2003 [The Dutch Standard Classification of Education]. Voorburg/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
27. Cohen J. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*. 1960;20(1):37-46.
28. Landis JR, Koch GG. The Measurement of Observer Agreement for Categorical Data. *Biometrics*. 1977;33(1):159-174.
29. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. *Journal of clinical epidemiology*. 1990;43(6):543-549.
30. Cicchetti DV, Feinstein AR. High agreement but low kappa: II. Resolving the paradoxes. *Journal of clinical epidemiology*. 1990;43(6):551-558.
31. Mast M, Kortzinger I, Konig E, Muller MJ. Gender differences in fat mass of 5-7-year old children. *Int J Obes Relat Metab Disord*. 1998;22(9):878-884.
32. van den Hurk K, van Dommelen P, van Buuren S, Verkerk PH, Hirasing RA. Prevalence of overweight and obesity in the Netherlands in 2003 compared to 1980 and 1997. *Archives of disease in childhood*. 2007;92(11):992-995.
33. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity (Silver Spring, Md*. 2008;16(2):275-284.
34. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr*. 2005;94(4):496-498.
35. Freedman DS, Wang J, Maynard LM, Thornton JC, Mei Z, Pierson RN, et al. Relation of BMI to fat and fat-free mass among children and adolescents. *International journal of obesity (2005)*. 2005;29(1):1-8.
36. Maynard LM, Wisemandle W, Roche AF, Chumlea WC, Guo SS, Siervogel RM. Childhood body composition in relation to body mass index. *Pediatrics*. 2001;107(2):344-350.

APPENDIX

Appendix 3.1 Calculation of kappa and proportions of agreement[27-30]

		BMI		
		Overweight	**Not overweight**	**Totals**
	Overweight	a	b	g_1
WC	**Not overweight**	c	d	g_2
	Totals	f_1	f_2	N

1) Observed total agreement = $\frac{a+d}{N}$

2) Agreement expected by chance = $\frac{f_1 g_1 + f_2 g_2}{N^2}$

3) Cohen's kappa = $\frac{1) - 2)}{1 - 2)}$

4) Positive agreement = $\frac{2a}{f_1 + g_1}$

5) Negative agreement = $\frac{2d}{f_2 + g_2}$

Appendix 3.2 Mean levels of WC and correlation between BMI and WC among subgroups of BMI (n = 7703)

Boys (n=3895)							
	BMI						
	Overall	**Overweight (obesity included)**		**Percentiles**			
		No	**Yes**	**< 25th**	**25th – 49th**	**50th – 74th**	**≥ 75th**
WC							
Mean (SD)[a]	53.4 (3.7)	52.8 (3.0)	60.5 (5.1)	50.7 (2.5)	52.4 (2.4)	53.7 (2.5)	56.8 (4.2)
Correlation[b]	0.73	0.58	0.67	0.27	0.17	0.18	0.72
Girls (n=3808)							
	BMI						
	Overall	**Overweight (obesity included)**		**Percentiles**			
		No	**Yes**	**< 25th**	**25th – 49th**	**50th – 74th**	**≥ 75th**
WC							
Mean (SD) [a]	53.2 (4.1)	52.4 (3.2)	59.6 (4.6)	50.2 (2.6)	51.9 (2.5)	53.4 (2.5)	57.4 (4.3)
Correlation[b]	0.76	0.60	0.71	0.28	0.18	0.21	0.71

[a] Differences in mean WC between groups overweight/non-overweight, and between different percentile-groups of BMI: all $p < 0.001$.

[b] Pearson's correlation coefficient r: all $p < 0.01$.

4

Influence of maternal and child lifestyle-related characteristics on the socioeconomic inequality in overweight and obesity among 5-year-old children; the 'Be active, eat right' study

Lydian Veldhuis
Ineke Vogel
Lenie van Rossem
Carry M. Renders
Remy A. HiraSing
Johan P. Mackenbach
Hein Raat

Int J Environ Res Public Health. 2013;10:2336

ABSTRACT

It is unclear whether the socioeconomic inequality in prevalence of overweight and obesity is already present among very young children. This study investigates the association between overweight and socioeconomic status (SES, with maternal educational level as an indicator of SES) among 5-year-old children. This cross-sectional study uses baseline data from 5-year-olds of Dutch ethnicity (n=5,582) and their mothers collected for the 'Be active, eat right' study. Compared to children of mothers with the highest educational level, for children of mothers with the lowest educational level the odds ratio (adjusted for demographic characteristics) for having overweight was 2.10 (95% confidence interval: 1.57-2.82), and for having obesity was 4.18 (95% confidence interval: 2.32-7.55). Addition of maternal and child lifestyle-related characteristics decreased the odds ratios for overweight and obesity by 26.4% and 42.1%, respectively. The results show that an inverse SES-overweight/obesity association is already present at elementary school entry, and that watching TV by mother and child, the child consuming breakfast and, especially maternal weight status, are contributing factors in this association. These results should be taken into account when developing policies to reduce inequalities in (childhood) health.

INTRODUCTION

Childhood overweight and obesity have increased at a dramatic rate worldwide and are a major burden on public health.[1, 2] Compared to higher socioeconomic status (SES) groups, subgroups in society with a lower SES are at increased risk for having overweight or obesity[1] and these differences in prevalence of overweight across SES groups may be established early in life.[3-5] In the last decades, studies investigating the association between SES and overweight among schoolchildren indeed found predominately inverse associations.[4, 6-8] Results of studies among younger children (aged <6 years) are however less consistent; some studies did find an association during early childhood,[8-12] while others did not.[13-15] Differences in the prevalence of childhood overweight across SES groups are likely to be explained by differences in characteristics of the children and their parents related to material circumstances, behavior and/or knowledge, all of which influence energy balance.[6, 9] Only few studies evaluated to what extent parental overweight and lifestyle-related behaviors of the child, i.e. playing outside, sedentary behavior, consuming breakfast and drinking sweet beverages, contribute to the association between SES and early childhood overweight;[6, 7] these lifestyle-related behaviors have been shown to be associated with both childhood overweight and indicators of SES.[16-20] Especially having an overweight parent is an important factor likely to influence the SES-overweight association among children, i.e. parental overweight reflects a combination of inherited genes and shared environment, and children are likely to learn behaviors related to energy intake/expenditure from their parents.[5, 6, 9, 21, 22] Understanding the influence of SES on patterns of eating and physical activity that lead to early childhood overweight and obesity is critical for the development of effective prevention programs.

In summary, more research is needed to establish whether socioeconomic inequality in the prevalence of overweight and obesity is already present in early childhood, also with regard to a timely start of overweight prevention programs. Therefore this study evaluates whether the educational level of the parent, as an indicator of SES, is associated with overweight/obesity among a large sample of 5-year-old children. Also investigated is the extent to which a potential association can be explained by lifestyle-related characteristics of the parent and child.

METHODS

Design and study population

The present cross-sectional study is embedded in the 'Be active, eat right' study, which aims to assess the effects of an overweight prevention protocol among children at elementary

school entry, throughout the Netherlands, as detailed elsewhere.[23] The Medical Ethics Committee of Erasmus MC University Medical Centre Rotterdam approved the study protocol.

Of the 37 municipal health services in the Netherlands, an opportunity sample of nine municipal health services agreed to participate in the 'Be active, eat right' study. A total of 13,638 parents of 5-year-olds were invited by mail for a well-child visit at one of these nine municipal health services. These parents were also invited to participate in the 'Be active, eat right' study and 64.4% provided written informed consent to participate in the study. Baseline data were collected during the 2007-2008 school year and were used for the present study.

Parental educational level is suggested to be an indicator of SES.[24] Besides material resources, parental educational level can also reflect a range of non-economic social characteristics with important health effects, such as health-related knowledge.[24] Parental educational level is likely to be a relatively stable indicator compared to, for example, parental income. It is also suggested that, especially the educational level of the mother, has a considerable influence on the development of children.[6, 25]

The present study used data of the children for whom the mother completed the questionnaire (n=7,682). In addition, we included an ethnically homogenous group as the association between SES and early childhood overweight may differ between ethnic subgroups.[7, 24, 26] Children with a Dutch ethnicity comprised the largest ethnic subgroup and were selected for analysis in the present study (n=6,641). A child was considered to be of non-Dutch ethnicity when at least one of the parents was born abroad, as defined by Statistics Netherlands.[27]

Children were excluded from the analysis when data were missing on height or weight of the child (n=20), sex or age of the child (n=6), lifestyle-related characteristics of the child (consuming breakfast, drinking sweet beverages, playing outside and watching television; TV) (n=685), educational level of the mother (n=26), age of the mother (n=6), single parenting or employment status of the mother (n=53), watching TV by the mother (n=166), and height or weight of the mother (n=97). After exclusion for any of these reasons, a study population of n=5,582 children remained for analysis.

Educational level of the mother

Maternal educational level was assessed by a questionnaire completed by the mothers. Educational level was recoded in three categories according to the Dutch standard classification as defined by Statistics Netherlands,[28] allowing meaningful comparison between subgroups of different educational level: high level (academic higher education/university education, higher professional education), mid level (pre-university education, senior general secondary education, and senior secondary vocational education), and low level (preparatory second-

ary vocational education, lower secondary vocational education, primary education, and no education).

Weight status of the child

Body weight and height of the children were measured by trained healthcare professionals of the municipal health services using standardized methods as described in a protocol.[17] Body weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm. Body mass index (BMI) was calculated by dividing weight (in kilograms) by height (in meters) squared. The weight status of the children was assessed according to the age-specific and sex-specific cut-off points for BMI as published by the International Obesity Task Force.[29] When a child's BMI value was the same as or higher than the lower-bound cut-off point for overweight or obesity for the child's age and sex, the child was classified as having overweight or obesity.

Demographic and lifestyle-related characteristics of the mother and child

Information on demographic and lifestyle-related characteristics of the mother and child were obtained via the questionnaire completed by the mothers. The categories are indicated below in parentheses. Of the maternal characteristics, we considered age, single parenting (two-parent families, single-parent family or otherwise specified), and employment status (employed full-time or part-time, not employed) to be potential confounders in the association between educational level of the mother and weight status of her child. Maternal weight status (no overweight, overweight, obesity) and watching TV (≤2 hours/day, >2 hours/day) by the mother were considered to be potential mediating characteristics. Self-reported height and weight of the mothers were used to calculate the BMI of the mothers. Mothers were classified as overweight when the BMI value was ≥25-30 kg/m^2 and were classified obese when the BMI value was ≥30 kg/m^2, as defined by the World Health Organization.[2] For the children, we considered age and sex to be potential confounders, and the lifestyle-related characteristics consuming breakfast (daily, <7 days/week), drinking sweet beverages (i.e. lemonade, soda, carbonated soda, fruit juice, sugar sweetened dairy products, etc.) (≤2 glasses/day, >2 glasses/day), playing outside (≥1 hour/day, <1 hour/day) and watching TV (≤2 hours/day, >2 hours/day) to be potential mediators in the association between educational level of the mother and weight status of the child. The categories used for the behaviors are based on established international recommendations.[17-19, 30-32]

Statistical analyses

Mean and frequency differences of the characteristics of the mothers and children, across maternal educational levels, were examined using analyses of variance (ANOVA) and Chi-square statistics. Multinomial logistic regression analyses were used to test the association between maternal educational level and overweight and obesity of the children. Odds ratios

Table 4.1 Characteristics of the total study population (n=5,582), and by educational level of the mother

	Frequency in the study population (%) (unless otherwise specified)				*P*-value[a]
	Total	Educational level of the mother[b]			
		High (n = 1,933)	Mid (n = 2,596)	Low (n = 1,053)	
Characteristics of the mother					
Mean age, years (SD)	36.5 (4.1)	37.5 (3.7)	36.1 (4.1)	36.0 (4.7)	<0.001
Mean height, cm (SD)	170.7 (6.2)	171.1 (5.9)	170.6 (6.3)	170.1 (6.2)	<0.001
Mean weight, kg (SD)	69.5 (12.3)	67.9 (11.2)	69.8 (12.5)	71.8 (13.4)	<0.001
Mean BMI (SD)	23.9 (4.0)	23.2 (3.6)	24.0 (4.1)	24.8 (4.4)	<0.001
Overweight[c]	1,234 (22.1)	326 (16.9)	608 (23.4)	300 (28.5)	<0.001
Obesity[c]	379 (6.8)	84 (4.3)	186 (7.2)	109 (10.4)	
Single parent	330 (5.9)	114 (5.9)	141 (5.4)	75 (7.1)	0.15
Not employed	1,424 (25.5)	326 (16.9)	667 (25.7)	431 (40.9)	<0.001
Watches TV >2 hours/day	2,537 (45.4)	570 (29.5)	1,315 (50.7)	652 (61.9)	<0.001
Characteristics of the child					
Boy	2,824 (50.6)	976 (50.5)	1,319 (50.8)	529 (50.2)	0.95
Mean age, years (SD)	5.7 (0.4)	5.7 (0.4)	5.7 (0.4)	5.8 (0.4)	<0.001
Mean height, cm (SD)	117.7 (5.5)	117.3 (5.4)	117.8 (5.6)	118.1 (5.6)	<0.001
Mean weight, kg (SD)	21.5 (3.2)	21.1 (2.9)	21.5 (3.3)	22.0 (3.5)	<0.001
Mean BMI (SD)	15.4 (1.5)	15.3 (1.3)	15.5 (1.5)	15.7 (1.6)	<0.001
Overweight[d]	386 (6.9)	95 (4.9)	188 (7.2)	103 (9.8)	<0.001
Obesity[d]	84 (1.5)	17 (0.9)	32 (1.2)	35 (3.3)	
Consuming breakfast <7 days/week	295 (5.3)	36 (1.9)	137 (5.3)	122 (11.6)	<0.001
Drinking sweet beverages >2 glasses/day	3,619 (64.8)	1,124 (58.1)	1,744 (67.2)	751 (71.3)	<0.001
Playing outside <1 hour/day	339 (6.1)	174 (9.0)	133 (5.1)	32 (3.0)	<0.001
Watching TV >2 hours/day	914 (16.4)	169 (8.7)	467 (18.0)	278 (26.4)	<0.001

BMI = body mass index; SD = standard deviation. [a] *P*-values for differences in characteristics across maternal educational levels; ANOVA's were used for continuous variables and Chi-square statistics for dichotomous variables. [b] High educational level = academic higher education (university education), higher professional education; mid educational level = pre-university education, senior general secondary education, and senior secondary vocational education; low educational level = preparatory secondary vocational education, lower secondary vocational education, primary education, and no education. [c] Overweight = BMI 25-30 (kg/m^2); obesity = BMI ≥30 (kg/m^2).[2] [d] According to age and sex-specific cut-off points for BMI as published by the International Obesity Task Force.[2]

(ORs) and 95% confidence intervals (CI) were obtained for each educational level and compared with the reference category (highest educational level).

The basic model investigated the association between maternal educational level, and overweight and obesity of the children. In the association with children's overweight (obesity included), there were no interactions between the maternal and child demographic and

lifestyle-related characteristics, and maternal educational level. To test the influence of the characteristics on the association, the characteristics were added to the basic model one at a time. For each adjustment, the percentage change in OR was calculated for the educational levels ($[OR_{basic\ model+characteristic} - OR_{basic\ model}]/[OR_{basic\ model} - 1] \times 100$).[33] Subsequently, the association between maternal educational level and children's overweight and obesity was analyzed, with adjustment for the relevant characteristics. A characteristic was considered relevant if the percentage change in ORs was >5% for an educational level subgroup.[33] This approach was applied to reduce the final number of variables included in the model. First, in model 1, we adjusted the association for the relevant confounding characteristics of the mother and child. Second, in model 2, we also adjusted the association for the relevant mediating characteristics of the mother. Finally, in model 3, we also added the mediating characteristics of the child. Statistical analyses were performed with PASW Statistics 17 for Windows (SPSS Inc, Chicago, IL).

RESULTS

Compared to the mothers/children with missing data (n=1,059), the population analyzed (n=5,582) included significantly more mothers with a high educational level ($p<0.001$), more mothers that were employed ($p<0.001$), more mothers that watched TV ≤2 hours/day ($p<0.05$), and more children who consumed breakfast daily ($p<0.05$) and watched TV ≤2 hours/day ($p<0.001$). There was no significant difference in weight status of the child ($p=0.41$) or maternal weight status ($p=0.14$) between the subgroup with missing data compared to the study population (data not shown).

Of all included mothers, mean age was 36.5 (SD 4.1) years, 22.1% had overweight, 6.8% had obesity, and 18.9% were in the group with the lowest educational level. Of the children, 51% were boys, mean age was 5.7 (SD 0.4) years, 6.9% had overweight, and 1.5% had obesity. All demographic and lifestyle-related characteristics of the mother and the child (except for single parenting and child's sex) were significantly associated with maternal educational level (Table 4.1).

In the basic model the association between maternal educational level and overweight and obesity of the children was investigated (Table 4.2, basic model). The characteristics that changed the ORs by >5% were: maternal age, maternal weight status, watching TV by the mother and the child, and the child consuming breakfast (Table 4.2).

In the model with adjustment for the confounding characteristic maternal age, compared to children in the subgroup with a mother with the highest educational level, the OR for having

Table 4.2 Multinomial logistic regression analyses for the association between maternal educational level and children's overweight and obesity, and change in ORs after adjustment for demographic and lifestyle-related characteristics of the mother and child (n = 5,582)

	High (ref) OR	Mid OR (95% CI)	Change 1[a]	Low OR (95% CI)	Change 2[a]
	Overweight (n = 386)				
Educational level of the mother[b] (basic model)	1.00	1.52 (1.18 – 1.96)		2.16 (1.62 – 2.88)	
Characteristics of the mother					
Basic model + age	**1.00**	**1.47 (1.14 – 1.90)**	**–9.6%**	**2.10 (1.57 – 2.82)**	**–5.2%**
Basic model + single parenting	1.00	1.52 (1.18 – 1.96)	0%	2.15 (1.61 – 2.88)	–0.9%
Basic model + employment status	1.00	1.53 (1.19 – 1.97)	1.9%	2.21 (1.64 – 2.97)	+4.3%
Basic model + weight status[c]	**1.00**	**1.42 (1.10 – 1.83)**	**–19.2%**	**1.91 (1.42 – 2.56)**	**–21.6%**
Basic model + watching TV	**1.00**	**1.49 (1.15 – 1.93)**	**–5.8%**	**2.10 (1.56 – 2.83)**	**–5.2%**
Characteristics of the child					
Basic model + sex	1.00	1.52 (1.18 – 1.97)	0%	2.17 (1.62 – 2.90)	+0.9%
Basic model + age	1.00	1.51 (1.17 – 1.95)	–1.9%	2.15 (1.61 – 2.88)	–0.9%
Basic model + consuming breakfast	**1.00**	**1.50 (1.16 – 1.94)**	**–3.8%**	**2.09 (1.56 – 2.81)**	**–6.0%**
Basic model + drinking sweet beverages	1.00	1.50 (1.16 – 1.94)	–3.8%	2.12 (1.59 – 2.84)	–3.4%
Basic model + playing outside	1.00	1.52 (1.18 – 1.96)	0%	2.17 (1.62 – 2.90)	+0.9%
Basic model + watching TV	**1.00**	**1.51 (1.17 – 1.95)**	**–1.9%**	**2.14 (1.60 – 2.87)**	**–1.7%**
	Obesity (n = 84)				
Educational level of the mother[b] (basic model)	1.00	1.44 (0.80 – 2.61)		4.10 (2.28 – 7.35)	
Characteristics of the mother					
Basic model + age	**1.00**	1.49 (0.82 – 2.70)	+11.4%	**4.18 (2.32 – 7.55)**	**+2.6%**
Basic model + single parenting	1.00	1.46 (0.81 – 2.63)	+4.5%	4.04 (2.25 – 7.25)	–1.9%
Basic model + employment status	1.00	1.43 (0.79 – 2.59)	–2.3%	4.01 (2.21 – 7.29)	–2.9%
Basic model + weight status[c]	**1.00**	1.29 (0.71 – 2.34)	–34.1%	**3.35 (1.85 – 6.07)**	**–24.2%**
Basic model + watching TV	**1.00**	1.30 (0.71 – 2.37)	–31.8%	**3.50 (1.92 – 6.40)**	**–19.4%**
Characteristics of the child					
Basic model + sex	1.00	1.45 (0.80 – 2.61)	2.3%	4.11 (2.29 – 7.38)	+0.3%
Basic model + age	1.00	1.44 (0.79 – 2.59)	0%	4.05 (2.25 – 7.27)	–1.6%
Basic model + consuming breakfast	**1.00**	1.43 (0.79 – 2.59)	–2.3%	**4.02 (2.22 – 7.26)**	**–2.6%**
Basic model + drinking sweet beverages	1.00	1.42 (0.79 – 2.57)	–4.5%	4.01 (2.23 – 7.23)	–2.9%
Basic model + playing outside	1.00	1.43 (0.79 – 2.58)	–2.3%	4.02 (2.24 – 7.24)	–2.6%
Basic model + watching TV	**1.00**	1.35 (0.75 – 2.45)	–20.5%	**3.63 (2.00 – 6.59)**	**–15.2%**

OR = odds ratio; CI = confidence interval. Model Fitting Information: basic model χ^2 (4) = 52.37, p<0.001. Results of Likelihood Ratio Tests: age mother χ^2 (6) = 6.13, p=0.41; single parenting χ^2 (2) = 11.19, p<0.05; employment status mother χ^2 (2) = 0.75, p=0.69; weight status mother χ^2 (4) = 59.57, p<0.001; watching TV by the mother χ^2 (4) = 4.86, p=0.09; sex child χ^2 (2) = 37.98, p<0.001; age child χ^2 (6) = 6.85, p=0.34; consuming breakfast child χ^2 (2) = 2.13, p=0.35; drinking sweet beverages child χ^2 (2) = 1.73, p=0.42; playing outside child χ^2 (2) = 0.56, p=0.75; watching TV child χ^2 (2) = 5.32, p=0.07. In these analyses, age of the mother and the child were included as categorical variables to reduce the number of cells with zero frequencies. [a] Change 1 and change 2 represent the change in OR relative to the basic model for mid and low education, respectively, after adjustment for lifestyle/demographic characteristics ($[OR_{basic\ model+characteristic} - OR_{basic\ model}]/[OR_{basic\ model} - 1] \times 100$). The changes in ORs >5% are indicated in bold numbers. [b] High educational level = academic higher education (university education), higher professional education; mid educational level = pre-university education, senior general secondary education, and senior secondary vocational education; low educational level = preparatory secondary vocational education, lower secondary vocational education, primary education, and no education. [c] Overweight = BMI 25-30 (kg/m^2); obesity = BMI ≥ 30 (kg/m^2).[2]

Table 4.3 Multinomial logistic regression analyses for the association between maternal educational level and children's weight status (n = 5,582)

	Model 1	Model 2	Change 1[a]	Model 3	Change 2[a]
	OR (95% CI)	OR (95% CI)		OR (95% CI)	
	Overweight (n = 386)				
Educational level of the mother[b]					
High	1.00	1.00		1.00	
Mid	1.47 (1.14 – 1.90)	1.37 (1.06 – 1.78)	–21.3%	1.36 (1.05 – 1.77)	–23.4%
Low	2.10 (1.57 – 2.82)	1.85 (1.37 – 2.51)	–22.7%	1.81 (1.33 – 2.46)	–26.4%
	Obesity (n = 84)				
Educational level of the mother[b]					
High	1.00	1.00		1.00	
Mid	1.49 (0.82 – 2.70)	1.22 (0.67 – 2.24)	–55.1%	1.19 (0.64 – 2.18)	–61.2%
Low	4.18 (2.32 – 7.55)	3.03 (1.64 – 5.60)	–36.2%	2.84 (1.52 – 5.29)	–42.1%

OR = odds ratio; CI = confidence interval. Model 1: educational level of the mother, adjusted for relevant confounding characteristics (maternal age). Model 2: model 1 + relevant mediating characteristics of the mother (weight status, watching TV). Model 3: model 2 + relevant mediating characteristics of the child (consuming breakfast, watching TV). Reference category is the subgroup of children without overweight. In these analyses, age of the mother and the child were included as categorical variables to reduce the number of cells with zero frequencies.
[a] Change 1 and change 2 represent the change in OR relative to model 1 for mid and low education, after adjustment for the mediating characteristics of the mother (model 2) and the child (model 3) ($[OR_{model2/3} - OR_{model1}]/[OR_{model1} - 1] \times 100$). [b] High educational level = academic higher education (university education), higher professional education; mid educational level = pre-university education, senior general secondary education, and senior secondary vocational education; low educational level = preparatory secondary vocational education, lower secondary vocational education, primary education, and no education.

overweight for children in the subgroup with a mother with a mid educational level was 1.47 (95% CI: 1.14-1.90), and for children in the subgroup with a mother with the lowest educational level the OR was 2.10 (95% CI: 1.57-2.82). For children in the subgroup with a mother with the lowest educational level, the OR for having obesity was 4.18 (95% CI: 2.32-7.55) (Table 4.3, model 1). Compared to model 1, addition of the mediating characteristics of the mother (weight status and watching TV) and the child (watching TV and consuming breakfast) to the model resulted in a total decrease in the ORs of 21.3% to 42.1% (Table 4.3, model 2 and model 3). For children with a mother with a mid educational level the OR for having overweight in the final model was 1.36 (95% CI: 1.05-1.77), and for children with a mother with the lowest educational level the OR was 1.81 (95% CI: 1.33-2.46). In the final model, for children in the subgroup with a mother with the lowest educational level, the OR for having obesity was 2.84 (95% CI: 1.52-5.29) (Table 4.3, model 3).

DISCUSSION

This study shows an inverse association between maternal educational level as an indicator of SES, and overweight and obesity among children at age 5 years. Adjustment for the mediating characteristics maternal weight status and watching TV by the mother decreased the odds for having overweight for a child in the subgroup with the lowest SES by 22.7%; for obesity, this decrease was 36.2%. Consuming breakfast and watching TV by the child, decreased these odds further by respectively 3.7% and 5.9%.

For the present study a large sample of young children throughout the Netherlands was included (n=5,582). However, this was an opportunity sample of nine out of 37 municipal health services that were able and willing to participate in the 'Be active, eat right' study. Because of the small age range, our results are specific to the 5-year-old age group. In addition, use of an ethnically homogenous group allowed to avoid the effect of ethnicity when evaluating the effect of educational level on overweight and obesity. The prevalence of overweight and obesity in our study population was 6.9% and 1.5%, respectively. In comparison, the prevalence rates for Dutch 5-year-olds in 2009 presented by a nationwide study were approximately 15.5% for overweight and 2.7% obesity.[34] There appeared to be some selection towards a study population with a higher SES and a somewhat healthier lifestyle, and the prevalence of overweight and obesity is probably underestimated in our study. Therefore, results should be generalized with caution. However, a clear inverse association was found between maternal educational level and children's risk for having overweight/obesity in our study population and (although we cannot confirm this) we think it unlikely that this association differs in the subgroup with missing data, or in the source population of Dutch 5-year-olds. Further, additional analysis after inclusion of the subgroup of children with missing values on lifestyle-related characteristics revealed that the results were similar to the included children (data not shown). Based on this, we assume that selection bias may not be a major threat to the validity of our results.

There are also other methodological considerations that need to be addressed. Limitations of this study are the use of cross-sectional data and the use of self-reported data for the characteristics of the mother and child. Maternal educational level was recoded in three categories, allowing meaningful comparisons between subgroups of different educational level. However, the subgroup of mothers categorized as having a low educational level is fairly heterogeneous; also mothers that reported no education at all were included in this subgroup (0.2% of the mothers in the total study population). Further, no information was available in the present study on, for example, physical activity of the parents, characteristics of the neighborhood environment (perceived safety, availability of parks, playgrounds, bike paths, etc.),[7] prenatal, perinatal and postnatal factors (such as maternal smoking during

pregnancy, birth weight, and receiving breastfeeding).[14] With regard to watching TV by the child and the mother, in this study, we asked in the questionnaire how much time was spent watching TV; and not for how long the TV was turned on during the day. However, for future studies we recommend to distinguish between watching TV as a primary activity, and having the TV turned on in the background in combination with other activities. Further, parents might have given socially desirable answers, although anonymity was assured. The height/weight of the children, on the other hand, was measured by trained healthcare professionals of the municipal health services.

A literature review (including 45 cross-sectional studies performed 1989-2005) concluded that school-aged children whose parents (particularly mothers) have a lower level of education were at higher than average risk to have overweight.[6] Relatively recent studies among 3-year-olds[13, 14] and 4-year-olds[15] found no association between SES and childhood overweight. The results of these previous studies, together with our results, suggest that (currently) differences in the prevalence of childhood overweight across SES-levels appear at the time of elementary school entry. Earlier studies including children at the age of about 5 years confirm this trend.[8-12]

Our study adds to the existing knowledge by demonstrating to what extent the inverse association between SES and early childhood overweight and obesity can be explained by lifestyle-related characteristics of the mother and child, including maternal overweight. Maternal weight status is a complex factor that can influence the SES-overweight/obesity association among children, as it represents both shared genes and lifestyle.[5, 6, 9, 21, 22] Maternal weight status appeared to be the most important explanatory factor in the present study, although the associations between SES and overweight/obesity among the children remained significant after adding this to the model. Lifestyle-related characteristics of the mother and the child further explained the increased risk for overweight/obesity for the lowest SES subgroup, but the SES-overweight/obesity association remained significant. Thus, the factors analyzed in the present study did not totally explain the SES-overweight/obesity association. Other factors such as characteristics of the neighborhood environment (perceived safety, availability of parks, playgrounds, bike paths, etc.),[7] prenatal, perinatal and postnatal factors (such as maternal smoking during pregnancy, birth weight, and receiving breastfeeding)[14] have been suggested in the literature as potential explanatory factors of the SES-overweight/obesity association, however, these factors were not available in the present study. We recommend future studies to include environmental factors, prenatal, perinatal and postnatal factors, parenting style and parenting practices, and specific measures of diet, sedentary and physical activity behaviors over time, to further explain differences in prevalence of early childhood overweight among subgroups of different SES.

CONCLUSIONS

In conclusion, this study shows that there is already a difference between SES groups in the presence of overweight and obesity at the start of elementary school. Compared to children of mothers with the highest educational level, the children of mothers with a lower educational level are at increased risk to have overweight and, in particular, to have obesity. This higher risk for the lower SES groups is explained by maternal and child lifestyle-related characteristics for >25% and >40%, respectively. Because differences in childhood overweight across SES subgroups may increase over time, which may contribute to increasing health inequalities,[5, 13, 22] it is important to start interventions to prevent overweight and obesity early in life. When developing overweight prevention programs for young children, the differences in risk should be taken into account and attention should be paid to the specific influence of maternal weight status and watching TV, as these factors appear to substantially contribute to the differences in risk for gaining overweight or obesity in children across SES subgroups.

REFERENCES

1. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev.* 2004;5 Suppl 1:4-104.
2. World Health Organization. Factsheet N0311, Obesity and overweight. May 2012. [http://www.who.int/mediacentre/factsheets/fs311/en/index.html] (accessed on 10 January 2013).
3. Hardy R, Wadsworth M, Kuh D. The influence of childhood weight and socioeconomic status on change in adult body mass index in a British national birth cohort. *Int J Obes Relat Metab Disord*. 2000;24(6):725-734.
4. Wardle J, Brodersen NH, Cole TJ, Jarvis MJ, Boniface DR. Development of adiposity in adolescence: five year longitudinal study of an ethnically and socioeconomically diverse sample of young people in Britain. *BMJ*. 2006;332(7550):1130-1135.
5. Knai C, Lobstein T, Darmon N, Rutter H, McKee M. Socioeconomic patterning of childhood overweight status in Europe. *International journal of environmental research and public health*. 2012;9(4):1472-1489.
6. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity (Silver Spring)*. 2008;16(2):275-284.
7. Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations. *Ann Epidemiol*. 2008;18(9):682-695.
8. Albertini A, Tripodi A, Fabbri A, Mattioli M, Cavrini G, Cecchetti R, et al. Prevalence of obesity in 6- and 9-year-old children living in Central-North Italy. Analysis of determinants and indicators of risk of overweight. *Obes Rev*. 2008;9(1):4-10.
9. Dubois L, Girard M. Early determinants of overweight at 4.5 years in a population-based longitudinal study. *International journal of obesity (2005)*. 2006;30(4):610-617.
10. Wake M, Hardy P, Canterford L, Sawyer M, Carlin JB. Overweight, obesity and girth of Australian preschoolers: prevalence and socio-economic correlates. *International journal of obesity (2005)*. 2007;31(7):1044-1051.
11. Huus K, Ludvigsson JF, Enskar K, Ludvigsson J. Risk factors in childhood obesity-findings from the All Babies In Southeast Sweden (ABIS) cohort. *Acta Paediatr*. 2007;96(9):1321-1325.
12. Brophy S, Cooksey R, Gravenor MB, Mistry R, Thomas N, Lyons RA, et al. Risk factors for childhood obesity at age 5: analysis of the millennium cohort study. *BMC Public Health*. 2009;9:467.
13. Brunt H, Lester N, Davies G, Williams R. Childhood overweight and obesity: is the gap closing the wrong way? *J Public Health (Oxf)*. 2008;30(2):145-152.
14. van Rossem L, Silva LM, Hokken-Koelega A, Arends LR, Moll HA, Jaddoe VW, et al. Socioeconomic status is not inversely associated with overweight in preschool children. *J Pediatr*. 2010;157(6):929-935 e921.
15. Semmler C, Ashcroft J, van Jaarsveld CH, Carnell S, Wardle J. Development of overweight in children in relation to parental weight and socioeconomic status. *Obesity (Silver Spring)*. 2009;17(4):814-820.
16. Whitaker RC. Obesity prevention in pediatric primary care: four behaviors to target. *Archives of pediatrics & adolescent medicine*. 2003;157(8):725-727.
17. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.

18. Davis MM, Gance-Cleveland B, Hassink S, Johnson R, Paradis G, Resnicow K. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007;120 Suppl 4:S229-253.
19. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-192.
20. Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. *Current opinion in clinical nutrition and metabolic care*. 2007;10(3):336-341.
21. Whitaker KL, Jarvis MJ, Beeken RJ, Boniface D, Wardle J. Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. *Am J Clin Nutr*. 2010;91(6):1560-1567.
22. Pinot de Moira A, Power C, Li L. Changing influences on childhood obesity: a study of 2 generations of the 1958 British birth cohort. *Am J Epidemiol*. 2010;171(12):1289-1298.
23. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, et al. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health*. 2009;9:177.
24. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. *JAMA*. 2005;294(22):2879-2888.
25. El-Sayed AM, Scarborough P, Galea S. Socioeconomic inequalities in childhood obesity in the United kingdom: a systematic review of the literature. *Obesity facts*. 2012;5(5):671-692.
26. Sue S, Dhindsa MK. Ethnic and racial health disparities research: issues and problems. *Health Educ Behav*. 2006;33(4):459-469.
27. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. 2004. Available from: http://www.cbs.nl/nl-NL/menu/themas/bevolking/publicaties/publicaties/archief/2004/2004-b52-pub.htm (accessed on 16 April 2009).
28. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Standaard Onderwijsindeling 2003 [The Dutch Standard Classification of Education]. 2004. Available from: http://www.cbs.nl/nl-NL/menu/methoden/classificaties/overzicht/soi/2003/default.htm (accessed on 16 April 2009).
29. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320(7244):1240-1243.
30. American Academy of Pediatrics. Committee on Nutrition: The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001;107(5):1210-1213.
31. American Academy of Pediatrics. Committee on Public Education: Children, adolescents, and television. *Pediatrics*. 2001;107(2):423-426.
32. Commonwealth Department of Health and Ageing. Australia's physical activity recommendations for 5-12 year kids. Canberra: Commonwealth of Australia. Available from: http://www.health.gov.au/internet/main/publishing.nsf/Content/9D7D393564FA0C42CA256F970014A5D4/$File/kids_phys.pdf (accessed on 14 October 2010).
33. Silva LM, Coolman M, Steegers EA, Jaddoe VW, Moll HA, Hofman A, et al. Low socioeconomic status is a risk factor for preeclampsia: the Generation R Study. *J Hypertens*. 2008;26(6):1200-1208.
34. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA, et al. Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PloS one*. 2011;6(11):e27608.

5

Ethnic background and overweight among 5-year-old children; the 'Be active, eat right' study

Lydian Veldhuis
Mara van Dooremaal
Willemieke Kroeze
Carry M. Renders
Remy A. HiraSing
Hein Raat

ISRN Pediatr. 2013;2013:861246

ABSTRACT

Introduction

This study investigates the association between ethnic background and overweight (obesity included) among 5-year-olds.

Methods

We used baseline data from 5-year-olds (n=7801) and their parents collected for the 'Be active, eat right' study. A child was considered to be of non-Dutch ethnic background when at least one of the parents was born abroad. Odds ratios (ORs) were adjusted for sociodemographic characteristics.

Results

Compared to children of Dutch ethnic background, for children with a Moroccan ethnic background the OR for having overweight (obesity included) was 2.27 (95% confidence interval (CI) 1.48-3.47), for Turkish children the OR was 3.63 (95% CI 2.46-5.35), for Antillean children the OR was 1.97 (95% CI 1.01-3.86) and for Surinamese children the OR was 0.47 (95% CI 0.20-1.06). Addition of parental overweight decreased the ORs for Moroccan and Turkish children by 10.2% and 12.5%, and addition of watching TV and having breakfast by the child decreased the ORs by 7.9% and 12.2%.

Conclusion

Already at a young age, children of Moroccan and Turkish ethnic background are at increased risk for having overweight compared to Dutch children. Parental overweight, watching TV and not having breakfast by the child are contributing factors in this association.

INTRODUCTION

The prevalence of overweight among children is substantial in most parts of the world.[1-3] Overweight during childhood is associated with risk factors for cardiovascular disease, type 2 diabetes, psychosocial problems, impaired quality of life, having overweight as an adult, and high economic costs.[2, 4] In addition to behavioral, environmental and socio-economic risk factors,[2, 5-8] being a child with an ethnic background different than the main ethnic group within a country, may be a specific risk factor.[9-14] Among children in European countries, there is a large diversity of ethnic groups. Ethnic subgroups are often minority groups with a lower socio-economic position than the main ethnic group within a country.[9] Lower socio-economic position and minority status are suggested to be associated with a lower health status, including overweight.[2, 8, 9, 15]

Recent studies on prevalence of overweight between subgroups of children of different ethnic background, were conducted in non-European countries, mainly in the USA.[11, 13, 16-20] The studies from the US showed that, overall, Mexican American children and non-Hispanic black children are at increased risk for having overweight or obesity, and that Asian American children have lower prevalences, compared to non-Hispanic white children. In Europe, there are differences between countries in the variety of non-native ethnic subgroups and having overweight or obesity. In the Netherlands, main non-Dutch subgroups are Moroccan, Turkish, Surinamese and Dutch Antillean, and it has been reported that children from Moroccan and Turkish ethnic background are at increased risk for having overweight and obesity.[10] Turkish is also one of the main ethnic subgroups in Germany with an increased risk for overweight,[12] while in Austria no difference in risk between Austrian and Turkish children was found.[14] In the UK, Chinese children have a lower risk for obesity, while there is no consensus on whether South Asian or black children are at increased risk, compared to Caucasian children.[21] These European studies included mainly school-aged children;[9, 14, 21] research in children below 6 years is limited.[10, 22, 23]

The determinants of ethnic disparities in childhood overweight and obesity remain poorly understood.[19] The prevalence differences between subgroups of different ethnic background are likely to be explained by characteristics of the children and parents related to material circumstances and behavior, which influence children's energy balance.[11] Parental weight status may be important in the association between children's ethnic background and weight status, as it represents shared genes and lifestyle.[2] The behaviors playing outside, watching TV, having breakfast and drinking sweet beverages by the children have been shown to be associated with childhood overweight.[24-28] The study of the interplay between ethnic background and lifestyle-related behaviors of the children, may be helpful for the development of effective prevention programs.[6, 11, 17] Only few studies reported to what extent parental

overweight or lifestyle-related behaviors of the child contribute to the association between ethnic background and childhood overweight.[12, 13, 16, 18, 23, 29, 30]

More research is needed to establish whether ethnic disparities in the prevalence of overweight are already present during early childhood in Europe, also with regard to a timely start of overweight prevention programs. Also research is needed to understand the underlying causes of ethnic disparities in overweight prevalence. Therefore the aim of our study was to investigate the association between ethnic background and overweight in a large sample of 5-year-old children in the Netherlands. Also investigated is the extent to which a potential association can be explained by parental overweight and lifestyle-related behaviors of the child.

METHODS

Design and study population

This study is embedded in the 'Be active, eat right' study. As detailed elsewhere,[31] the 'Be active, eat right' study aims to assess the effects of an overweight prevention program among children at elementary school throughout the Netherlands. The Medical Ethics Committee of the Erasmus MC (University Medical Centre Rotterdam, the Netherlands) approved the study protocol.

Of the 37 municipal health services in the Netherlands, nine municipal health services agreed to participate in the study. A total of 13,638 parents of 5-year-olds were invited by mail for a free of charge well-child visit (attendance rate 95%)[32] at one of these nine participating municipal health services and 64.4% (n=8784) provided written informed consent to participate in the study. Baseline data of the children and their parents were collected during the 2007-2008 school year and these data were used for the present study. Of the parents, 8683 (98.9%) completed a questionnaire with items on demographic, socio-economic and lifestyle-related characteristics of themselves and their child. Data on height and weight, measured by health-care professionals during the well-child visit, was available for 8750 (99.6%) children.

Of the in total 8784 children participating in the study, 141 children were excluded from the analysis because of missing data on height, weight, age and/or gender, as this information was needed to determine the child's weight status (see below). Children were also excluded from analysis when data was missing on their ethnic background (n=78). Children with a Moroccan, Turkish, Surinamese or Dutch Antillean ethnic background were the largest non-Dutch ethnic subgroups (see below). Children with an 'other-Western' (n=452) and an 'other

non-Western' ethnic background (n=312) were excluded, because of the mixed composition of these groups. Finally, 7801 children were available for analysis.

Ethnic background of the child

A child was considered to be of non-Dutch ethnic background when at least one of the parents was born abroad, as defined by Statistics Netherlands.[33] If at least one parent was born abroad and the child was also born abroad, the country of birth of the child determined the subgroup. If one of the parents was born abroad and the child was not, the country of birth of that parent determined the ethnic background. If both parents were born abroad and the child was not, the country of birth of the mother determined the ethnic background of the child.

Weight status of the child

Body weight and height were measured by trained healthcare professionals of the municipal health services using standardized methods as described in a protocol.[34] Body weight was measured to the nearest 0.1 kilograms and height to the nearest 0.1 centimeter. Body mass index (BMI) was calculated by dividing weight (in kilograms) by height (in meters) squared. The weight status of the children was assessed according to the age-specific and gender-specific cut-off points for body mass index (BMI) as published by the International Obesity Task Force (IOTF).[35] When a child's BMI value was the same as or higher than the lower-bound cut-off point for overweight for the child's age and gender, the child was classified as having overweight (obesity included). Overweight and obesity were combined, allowing meaningful comparisons between the subgroups of different ethnic background.

Socio-demographic characteristics, parental overweight and lifestyle-related behaviors of the child

Socio-demographic characteristics of the child, parent and family and parental overweight were considered potential confounders, and lifestyle-related behaviors of the child were considered potential mediators in the ethnic background-overweight association.[1, 2, 5, 7, 8, 36-39] Information on the gender and age of the child and the parent who completed the questionnaire, educational level and height and weight of the parent and family situation were obtained by the questionnaire. Educational level of the parent was recoded in three categories according to the Dutch standard classification as defined by Statistics Netherlands:[40] low level (no education, primary school, lower vocational school or intermediate general secondary school); mid level (higher general secondary school or intermediate vocational training); and high level (higher vocational training or academic education). Self-reported height and weight of the parent were used to calculate BMI. Parents were classified as overweight (obesity included) when the BMI value was ≥ 25 kg/(m)^2, as defined by the World Health Organization.[3] Family situation was recoded as a two-parent family, or otherwise.

Four lifestyle-related behaviors of the child were assessed also by the questionnaire completed by the parent. Parents reported the following behaviors of the child: playing outside (recoded as ≥1 hour/day, <1 hour/day), watching television (TV) (recoded as ≤2 hours/day, >2 hours/day), having breakfast (recoded as 7 days/week, <7 days/week) and drinking sweet beverages (i.e. lemonade, soda, carbonated soda, fruit juice, sugar sweetened dairy products, etc.) (recoded as ≤4 glasses/day, >4 glasses/day). The categories used for the behaviors are based on international recommendations.[26, 27, 41, 42] In this study, the four lifestyle-related behaviors of the child are hypothesized to be intermediate factors in the causal pathway between ethnic background and childhood overweight; therefore we considered them to be potential mediators.

Statistical analysis

Differences in baseline characteristics between the subgroups of non-Dutch children and Dutch children were examined using the Chi-square statistic for categorical variables and analysis of variance (ANOVA) for continuous variables. If the percentage of missing values in the study population did not exceed five percent, subjects with missing values on that variable were assigned to the most prevalent category for that variable.[43] If more than five percent were missing on a variable, a separate missing category was included for the analyses (this was only the case for the variables playing outside and watching TV). Multivariable logistic regression analyses were used to study the association between ethnic background of the child and having overweight (obesity included). Odds ratios (ORs) and 95% confidence intervals (CIs) were obtained for each ethnic subgroup and compared with the reference category (children of Dutch ethnic background).

The basic model investigated the association between ethnic background of the child and having overweight (obesity included). In the association with children's weight status, there were no interactions between sociodemographic characteristics, parental overweight, and ethnic background of the child (all p-values >0.10). Further, because the variables age and gender of the child, and age of the parent, appeared not to be confounders in the association between ethnic background of the child and having overweight, these variables were not included in the models.

First, the basic model was adjusted for the following confounders: gender of the parent, educational level of the parent and family situation (model 1). In addition, we adjusted model 1 for the confounder parental overweight (model 2); the variable parental overweight (yes/no) was added as a separate step to the model, since it may reflect a genetic predisposition to overweight of the child, and may reflect an environment that might be associated with behaviors predisposing to overweight in childhood.[6, 7] To test the influence of the po-

tential mediating lifestyle-related behaviors of the child on the association between ethnic background and overweight (obesity included), the characteristics were added to model 2 one at a time. For each adjustment, the percentage change in OR was calculated for the subgroups of ethnic background ($[OR_{model\ 2+lifestyle\text{-}related\ behavior} - OR_{model\ 2}]/[OR_{model\ 2} - 1] \times 100$).[44, 45] A lifestyle-related behavior was considered relevant if the percentage change in the ORs for having overweight was >5% within an ethnic background subgroup. Subsequently, in model 3 (i.e. the final model), the association between ethnic background of the child and having overweight (obesity included) was adjusted also for the relevant mediating lifestyle-related behaviors; in this study, watching TV and having breakfast by the child (adding the behaviors drinking sweet beverages and playing outside to the model resulted in changes in the ORs of <5%).

The analyses were performed using Statistical Package of Social Sciences version 17.0 for Windows.

RESULTS

Table 5.1 shows the general characteristics of the total study population (n=7801), and by ethnic background of the child. Mean age of the children was 5.7 (SD 0.4) years; 48.9% were girls. The prevalence of overweight (including obesity) was 8.2% among children of Dutch ethnic background, 19.1% among Moroccan, 27.4% among Turkish, 4.4% among Surinamese and 17.2% among children of Dutch Antillean ethnic background ($p < 0.01$) (Table 5.1). There were statistically significant differences regarding the characteristics of the parent and family, and regarding the lifestyle-related behaviors of the child between Dutch children and the subgroups of children with a non-Dutch ethnic background.

Table 5.1 General characteristics of the total study population, and by ethnic background of the child (n=7801)

	Total (n=7801)	Dutch (n=7302) (reference group)	Moroccan (n=152)	Turkish (n=146)	Surinamese (n=137)	Dutch Antillean (n=64)
Child characteristics						
Gender of child						
Girl (%)	48.9	48.9	49.3	50.7	46.0	50.0
Age of child (years)						
Mean (SD)	5.7 (0.4)	5.7 (0.4)	5.8 (0.5)	5.8 (0.5)	5.9 (0.4)	5.7 (0.5)
Overweight child						
Overweight (obesity included) (%)	8.8	8.2	19.1 **	27.4 **	4.4	17.2 **
Characteristics of parent						
Gender of responding parent						
Woman (%)	89.9	90.9	67.8 **	65.1 **	83.9 **	93.8
Age of parent (years)						
Mean (SD)	36.6 (4.5)	36.7 (4.4)	36.1 (6.9)	33.8 (4.8) **	36.7 (5.6)	35.6 (5.9)
Educational level of parent						
Low (%)	21.8	20.6	47.7	54.6	23.5	22.6
Mid (%)	45.3	45.4	41.7	36.9	50.7	58.4
High (%)	32.8	33.9	10.6 **	8.5 **	25.7	29.0
Parental overweight						
Overweight (obesity included) (%)	31.1	29.9	48.0 **	56.8 **	40.1	48.4 **
Family characteristics						
Family situation						
Two-parent family (%)	93.3	94.1	87.5	91.8	78.1	59.4
Otherwise (%)	6.7	5.9	12.5 **	8.2	21.9 **	40.6 **[b]
Lifestyle-related behaviors child						
Playing outside						
≥1 hour/day (%)	83.3	83.8	72.4	76.7	79.6	75.0
< 1 hour/day (%)	5.4	5.4	6.6	4.8	9.5	1.6
Missing (%)	11.3	10.8	21.1 **	18.5 *	10.9	23.4 **[b]

Table 5.1 (Continued)

	Total (n=7801)	Dutch (n=7302) (reference group)	Moroccan (n=152)	Turkish (n=146)	Surinamese (n=137)	Dutch Antillean (n=64)
Watching TV						
≤ 2 hours/day (%)	76.7	78.6	39.5	45.9	61.3	54.7
> 2 hours/day (%)	16.2	14.9	42.8	37.7	28.5	28.1
Missing (%)	7.1	6.6	17.8 **	16.4 **	10.2 **	17.2 **b
Having breakfast						
7 days/week (%)	93.5	94.4	87.5	65.1	86.9	87.5
< 7 days/week (%)	6.5	5.6	12.5 **	34.9 **	13.1 **	12.5 *b
Sweet beverages						
≤ 4/day (%)	84.0	84.4	77.6	84.9	74.5	70.3
> 4 day (%)	16.0	15.6	22.4 *	15.1	25.5 **	29.7 **

SD = standard deviation. P-values are for chi-squared tests (categorical factors) or one-way analysis of variance (continuous factors). * $p < 0.05$, ** $p < 0.01$. [a] Overweight (obesity included) = BMI ≥25 (kg/m^2).[3] [b] p-value also based on Fisher's exact test because of small groups.

In the model with adjustment for the confounding characteristics (Table 5.2, model 1), the OR for having overweight (obesity included) among the Moroccan subgroup was 2.27 (95% CI 1.48-3.47), among Turkish children the OR was 3.63 (95% CI 2.46-5.35), among Dutch Antillean children the OR was 1.97 (95% CI 1.01-3.86), and the OR among Surinamese children was 0.47 (95% CI 0.20-1.06), compared to children with a Dutch ethnic background. After additional adjustment for parental overweight (Table 5.2, model 2), the ORs for having overweight for the non-Dutch ethnic subgroups decreased in the range from 7.5% to 27.8%.

In the final model (Table 5.3, model 3), with addition of the two relevant mediators (watching TV and having breakfast by the child), the ORs for having overweight among Moroccan children further decreased by 7.9% to 2.05 (95% CI 1.33-3.15), for Turkish children the OR further decreased by 12.2% to 3.02 (95% CI 2.02-4.50), and for Dutch Antillean children the OR further decreased by 8.6% to 1.64 (95% CI 0.83-3.25). For Surinamese children, the OR for having overweight in the final model was 0.41 (95% CI 0.18-0.95) (Table 5.3).

Table 5.2 Logistic regression analyses for the association between ethnic background and overweight (obesity included) among 5-year-olds, and change in ORs after adjustment for lifestyle-related behaviors of the child (n =7801)

	Dutch (ref) OR	Moroccan OR (95% CI)	Change a[a] (%)	Turkish OR (95% CI)	Change b[a] (%)	Surinamese OR (95% CI)	Change c[a] (%)	Dutch Antillean OR (95% CI)	Change d[a] (%)
Model 1	1.00	2.27 (1.48-3.47)		3.63 (2.46-5.35)		0.47 (0.20-1.06)		1.97 (1.01-3.86)	
Model 2	1.00	2.14 (1.39-3.28)	-10.2	3.30 (2.23-4.87)	-12.5	0.43 (0.19-0.98)	-7.5	1.70 (0.86-3.35)	-27.8
Lifestyle-related behaviors child			**Change a[b] (%)**		**Change b[b] (%)**		**Change c[b] (%)**		**Change d[b] (%)**
Model 2 + playing outside	1.00	2.14 (1.40-3.29)	0.0	3.30 (2.24-4.88)	0.0	0.43 (0.19-0.98)	0.0	1.71 (0.87-3.37)	-1.4
Model 2 + watching TV	1.00	2.05 (1.33-3.16)	-7.9	3.21 (2.16-4.75)	-3.9	0.42 (0.18-0.96)	+1.8	1.67 (0.84-3.29)	-4.3
Model 2 + having breakfast	1.00	2.12 (1.38-3.26)	-1.8	3.09 (2.07-4.60)	-9.1	0.42 (0.18-0.96)	+1.8	1.68 (0.85-3.31)	-2.9
Model 2 + sweet beverages	1.00	2.13 (1.39-3.27)	-0.9	3.32 (2.24-4.90)	+0.9	0.42 (0.18-0.97)	+1.8	1.68 (0.85-3.32)	-2.9

OR = odds ratio, CI = confidence interval. Model 1: ethnic background of the child + gender of the parent, educational level of the parent, family situation

Model 2: model 1 + parental overweight (overweight (obesity included) = BMI ≥25 (kg/m^2)[3]) [a] Change a, b, c and change d represent the respective changes in OR for children with a Moroccan, Turkish, Surinamese and Dutch Antillean ethnic background relative to model 1, after adjustment for parental overweight ($[OR_{model\ 2} - OR_{model\ 1}]/[OR_{model\ 1} - 1] \times 100$). [b] Change a, b, c and change d represent the respective changes in OR for children with a Moroccan, Turkish, Surinamese and Dutch Antillean ethnic background relative to model 2, after individual adjustment for lifestyle-related behaviors of the child ($[OR_{model\ 2+lifestyle\text{-}related\ behavior} - OR_{model\ 2}]/[OR_{model\ 2} - 1] \times 100$).

Table 5.3 Logistic regression analyses for association between ethnic background and overweight (obesity included) among 5-year-olds, after adjustment for confounders and mediators (n=7801)

Ethnic background child	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Change a[a] (%)
Dutch	1.00 (reference)	1.00 (reference)	
Moroccan	2.14 (1.39-3.28)	2.05 (1.33-3.15)	-7.9%
Turkish	3.30 (2.23-4.87)	3.02 (2.02-4.50)	-12.2%
Surinamese	0.43 (0.19-0.98)	0.41 (0.18-0.95)	+3.5%
Dutch Antillean	1.70 (0.86-3.35)	1.64 (0.83-3.25)	-8.6%

OR = odds ratio; CI = confidence interval. Model 2: ethnic background of the child + gender of the parent, educational level of the parent, family situation + parental overweight (overweight (obesity included) = BMI ≥25 (kg/m^2)).[3] Model 3: model 2 + relevant lifestyle-related behaviors of the child (watching TV, having breakfast) (see Table 5.2). [a] Change a represents the respective change in OR for children with a Moroccan, Turkish, Surinamese and Dutch Antillean ethnic background relative to model 2, after adjustment for mediators, the lifestyle-related behaviors of the child (model 3) ($[OR_{model\ 3} - OR_{model\ 2}]/[OR_{model\ 2} - 1] \times 100$).

DISCUSSION

This study shows that children with a Moroccan and Turkish ethnic background are at increased risk for having overweight (obesity included) compared to children of Dutch ethnic background. Adjustment for parental overweight decreased the odds for overweight (obesity included) for children with a Moroccan ethnic background with 10.2% and for children with a Turkish ethnic background with 12.5%. Taking into account lifestyle-related behaviors of the child (watching TV and having breakfast) the odds further decreased by respectively 7.9% and 12.2%. The risk for having overweight among children of Dutch Antillean ethnic background did not differ significantly from Dutch children. Surinamese children had lower risk for overweight.

For the present study a large sample (n=7801) of young children throughout the Netherlands with a small age range was included, therefore our results are specific to the 5-year-old age group. However, this was an opportunity sample of 9 out of 37 municipal health services that were able and willing to participate in the study. The prevalence of overweight (obesity included) in our study population was 8.2% for Dutch children, 19.1% for children of Moroccan ethnic background, and 27.4% for children of Turkish ethnic background. In comparison, the prevalence rates for 5-year-olds presented by a nationwide study were approximately 15% for Dutch children, 26% for children of Moroccan ethnic background, and 31% for children of Turkish ethnic background.[10] Therefore, the prevalence of overweight (obesity included) is probably underestimated in our study, and results should be generalized with caution. However, clear increased risks for having overweight (obesity included) were found for children of Moroccan or Turkish ethnic background, and (although we cannot confirm this) we assume that our findings are the same in the source population of 5-year-olds living in the Netherlands.

There are also other methodological considerations that need to be addressed. Limitations of this study are the use of cross-sectional data and the use of self-reported data for the characteristics of the parents (including height and weight) and the children, which may have introduced bias such as recall bias. Further, parents may have given socially desirable answers, although anonymity was assured. It was not possible in the study to specifically assess energy intake/expenditure, e.g. through a food frequency questionnaire and accelerometer. Further, in the present study no information was available on, for example, prenatal, perinatal or postnatal factors (such as maternal smoking during pregnancy, birth weight, and receiving breastfeeding). Height and weight of the children were, however, measured by trained healthcare professionals of the municipal health services.

The term ethnic background is a social construct; it is constantly evolving and it is not a fixed concept. Ethnic self-identification can change across generations or even change over time within a generation.[17] We based the definition of ethnic background of the child on country of birth, as defined by Statistics Netherlands,[33] as this is the most objective and stable measure to use among young children in the context of the Netherlands.[46] With our data we could not evaluate indicators for the level of family acculturation in the society, which may be relevant for examining differences in the prevalence of overweight.[47] We therefore recommend future studies to also investigate a wide range of aspects related to ethnic background with regard to the association with childhood overweight, such as culture and ethnic identity.[46]

It may be that ethnic background and indicators of socioeconomic status (SES), such as parental educational level, interact with each other in their association with childhood overweight.[13, 17, 30, 48, 49] This appeared not to be the case in our study; no interaction was found between parental educational level and ethnic background of the child in the association with children's weight status (see also the Methods section). This indicates that within the subgroup of children with a parent with a low educational level, children with a Moroccan or Turkish ethnic background are also at increased risk for having overweight, compared to Dutch children. This finding provides further evidence that the effect of ethnic background may be independent of the effect of SES on the risk for overweight among the children.

Our finding of a higher risk for having overweight among children with a Moroccan or Turkish ethnic background compared to children of Dutch ethnic background in the Netherlands, are in line with the results of previous studies (which included study populations with other or wider age ranges).[10, 22, 23] In contrast; it is known from literature that in Turkey the prevalence of overweight among Turkish children aged 6-17 years is lower than in most European countries.[50] However, when people no longer live in their country of origin, their eating and drinking habits and physical activity behaviors may change.[17]

Up to now, the prevalence of overweight among Surinamese and Dutch Antillean children was less well examined. One study found no differences in overweight prevalence between Dutch children and children of Surinamese South Asian ethnic background.[22] In our study, Surinamese children had a statistically significant lower risk for having overweight compared to Dutch children. It has been indicated in the literature that the average macronutrient intake of Surinamese children in the Netherlands is more in line with the guidelines for a healthy diet compared to the conventional Dutch diet.[9] So, Surinamese children might have healthier behaviors linked to diet. However, we were unable to confirm this with regard to the four lifestyle-related behaviors of the children in our study. On the contrary, we found that Surinamese children less often had breakfast daily and had a higher intake of sweet beverages compared to Dutch children. By interpreting the results for this subgroup, it should be taken into account that we included a relatively small group of children with a Surinamese ethnic background in our study population. Further, the composition of this subgroup might be mixed as Surinam is a multiethnic society with people originated from China, Indonesia, India, the Netherlands and Africa.[22] So, future research should further investigate this potential lower risk for having overweight among a larger and varied group of Surinamese children, and in which more detailed information about diet and other lifestyle-related behaviors should be included.

CONCLUSIONS

In conclusion, this study shows that already in 5-year-old children there are considerable differences in the prevalence of overweight (including obesity) between ethnic subgroups. Children of Moroccan and Turkish ethnic background are at increased risk for having overweight compared to children of Dutch ethnic background. Not all ethnic groups appeared to be at increased risk for having overweight; the prevalence of overweight among the subgroup with a Dutch Antilles ethnic background did not differ significantly from Dutch children, and the prevalence among Surinamese children was lower. The higher risk for Moroccan and Turkish children is explained by parental weight status for >10%. Also, the behaviors watching TV and not having breakfast by the child appeared to contribute in explaining the higher risk for Moroccan and Turkish children (respectively for 7.9% and 12.2%). We recommend that future studies investigate parenting factors, social-cultural determinants, prenatal, perinatal and postnatal factors, and specific measures of diet, sedentary and physical activity behaviors over time, to further explain differences in prevalence of early childhood overweight among ethnic subgroups living in the same country. When developing overweight prevention programs for young children, e.g. for use during well-child or pediatric visits to counsel and advise parents, attention should be paid to the differences in risk across ethnic subgroups. As

parental weight status and the lifestyle-related behaviors watching TV and having breakfast by the child appear to contribute to the increased risk for Turkish and Moroccan subgroups, these factors should be taken into account by tailoring the interventions to the specific subgroups involved.

REFERENCES

1. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet*. 2002;360(9331):473-482.
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
3. World Health Organization. Factsheet Nº311, Obesity and overweight. Available from http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed March 2012: World Health Organization; February 2011.
4. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics*. 1998;101(3 Pt 2):518-525.
5. Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best practice & research*. 2005;19(3):343-358.
6. Kumanyika SK. Environmental influences on childhood obesity: ethnic and cultural influences in context. *Physiology & behavior*. 2008;94(1):61-70.
7. Ritchie LD, Welk G, Styne D, Gerstein DE, Crawford PB. Family environment and pediatric overweight: what is a parent to do? *Journal of the American Dietetic Association*. 2005;105(5 Suppl 1):S70-79.
8. Danielzik S, Czerwinski-Mast M, Langnase K, Dilba B, Muller MJ. Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7 y-old children: baseline data of the Kiel Obesity Prevention Study (KOPS). *Int J Obes Relat Metab Disord*. 2004;28(11):1494-1502.
9. Brussaard JH, van Erp-Baart MA, Brants HA, Hulshof KF, Lowik MR. Nutrition and health among migrants in The Netherlands. *Public health nutrition*. 2001;4(2B):659-664.
10. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr*. 2005;94(4):496-498.
11. Wang Y, Beydoun MA. The obesity epidemic in the United States--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiologic reviews*. 2007;29:6-28.
12. Kuepper-Nybelen J, Lamerz A, Bruning N, Hebebrand J, Herpertz-Dahlmann B, Brenner H. Major differences in prevalence of overweight according to nationality in preschool children living in Germany: determinants and public health implications. *Archives of disease in childhood*. 2005;90(4):359-363.
13. Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations. *Ann Epidemiol*. 2008;18(9):682-695.
14. Kirchengast S, Schober E. To be an immigrant: a risk factor for developing overweight and obesity during childhood and adolescence? *Journal of biosocial science*. 2006;38(5):695-705.
15. Bongard S, Pogge SF, Arslaner H, Rohrmann S, Hodapp V. Acculturation and cardiovascular reactivity of second-generation Turkish migrants in Germany. *Journal of psychosomatic research*. 2002;53(3):795-803.
16. Kimbro RT, Brooks-Gunn J, McLanahan S. Racial and ethnic differentials in overweight and obesity among 3-year-old children. *American journal of public health*. 2007;97(2):298-305.

17. Caprio S, Daniels SR, Drewnowski A, Kaufman FR, Palinkas LA, Rosenbloom AL, et al. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment. *Obesity (Silver Spring, Md*. 2008;16(12):2566-2577.
18. Taveras EM, Gillman MW, Kleinman K, Rich-Edwards JW, Rifas-Shiman SL. Racial/ethnic differences in early-life risk factors for childhood obesity. *Pediatrics*. 2010;125(4):686-695.
19. Wang Y. Disparities in pediatric obesity in the United States. *Advances in nutrition (Bethesda, Md*. 2011;2(1):23-31.
20. Rossen LM, Schoendorf KC. Measuring health disparities: trends in racial-ethnic and socioeconomic disparities in obesity among 2- to 18-year old youth in the United States, 2001-2010. *Ann Epidemiol*. 2012;22(10):698-704.
21. El-Sayed AM, Scarborough P, Galea S. Ethnic inequalities in obesity among children and adults in the UK: a systematic review of the literature. *Obes Rev*. 2011;12(5):e516-534.
22. de Wilde JA, van Dommelen P, Middelkoop BJ, Verkerk PH. Trends in overweight and obesity prevalence in Dutch, Turkish, Moroccan and Surinamese South Asian children in the Netherlands. *Archives of disease in childhood*. 2009;94(10):795-800.
23. de Hoog ML, van Eijsden M, Stronks K, Gemke RJ, Vrijkotte TG. Overweight at age two years in a multi-ethnic cohort (ABCD study): the role of prenatal factors, birth outcomes and postnatal factors. *BMC public health*. 2011;11:611.
24. Whitaker RC. Obesity prevention in pediatric primary care: four behaviors to target. *Archives of pediatrics & adolescent medicine*. 2003;157(8):725-727.
25. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.
26. Davis MM, Gance-Cleveland B, Hassink S, Johnson R, Paradis G, Resnicow K. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007;120 Suppl 4:S229-253.
27. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-192.
28. Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. *Current opinion in clinical nutrition and metabolic care*. 2007;10(3):336-341.
29. Harding S, Teyhan A, Maynard MJ, Cruickshank JK. Ethnic differences in overweight and obesity in early adolescence in the MRC DASH study: the role of adolescent and parental lifestyle. *International journal of epidemiology*. 2008;37(1):162-172.
30. Waters E, Ashbolt R, Gibbs L, Booth M, Magarey A, Gold L, et al. Double disadvantage: the influence of ethnicity over socioeconomic position on childhood overweight and obesity: findings from an inner urban population of primary school children. *Int J Pediatr Obes*. 2008;3(4):196-204.
31. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, et al. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC public health*. 2009;9:177.
32. Renders CM, Halberstadt J, Frenkel CS, Rosenmoller P, Seidell JC, Hirasing RA. Tackling the problem of overweight and obesity: the dutch approach. *Obesity facts*. 2010;3(4):267-272. Epub 2010 Aug 2013.
33. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. Den Haag/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.

34. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Signaleringsprotocol Overgewicht in de Jeugdgezondheidszorg [Youth Health Care Overweight-detection-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; November 2004.
35. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed*. 2000;320(7244):1240-1243.
36. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *The American journal of clinical nutrition*. 2006;84(2):274-288.
37. Anderson SE, Economos CD, Must A. Active play and screen time in US children aged 4 to 11 years in relation to sociodemographic and weight status characteristics: a nationally representative cross-sectional analysis. *BMC public health*. 2008;8:366.
38. Laurson KR, Eisenmann JC, Welk GJ, Wickel EE, Gentile DA, Walsh DA. Combined influence of physical activity and screen time recommendations on childhood overweight. *The Journal of pediatrics*. 2008;153(2):209-214.
39. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association*. 2005;105(5):743-760; quiz 761-742.
40. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Standaard Onderwijsindeling 2003 [The Dutch Standard Classification of Education]. Voorburg/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
41. American Academy of Pediatrics. Committee on Public Education: Children, adolescents, and television. *Pediatrics*. 2001;107(2):423-426.
42. American Academy of Pediatrics. Committee on Nutrition: The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001;107(5):1210-1213.
43. Harrell FE. *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis*: Springer; 2001.
44. Van De Mheen H, Stronks K, Van Den Bos J, Mackenbach JP. The contribution of childhood environment to the explanation of socio-economic inequalities in health in adult life: A retrospective study. *Social Science & Medicine*. 1997;44(1):13-24.
45. Silva LM, Coolman M, Steegers EA, Jaddoe VW, Moll HA, Hofman A, et al. Low socioeconomic status is a risk factor for preeclampsia: the Generation R Study. *J Hypertens*. 2008;26(6):1200-1208.
46. Stronks K, Kulu-Glasgow I, Agyemang C. The utility of 'country of birth' for the classification of ethnic groups in health research: the Dutch experience. *Ethnicity & health*. 2009;14(3):255-269.
47. Sussner KM, Lindsay AC, Peterson KE. The influence of maternal acculturation on child body mass index at age 24 months. *Journal of the American Dietetic Association*. 2009;109(2):218-225.
48. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. *Jama*. 2005;294(22):2879-2888.
49. Sue S, Dhindsa MK. Ethnic and racial health disparities research: issues and problems. *Health Educ Behav*. 2006;33(4):459-469.
50. Simsek E, Akpinar S, Bahcebasi T, Senses DA, Kocabay K. The prevalence of overweight and obese children aged 6-17 years in the West Black Sea region of Turkey. *International journal of clinical practice*. 2008;62(7):1033-1038.

6

Behavioral risk factors for overweight in early childhood; the 'Be active, eat right' study

Lydian Veldhuis
Ineke Vogel
Carry M. Renders
Lenie van Rossem
Anke Oenema
Remy A. HiraSing
Hein Raat

Int J Behav Nutr Phys Act. 2012;9:74

ABSTRACT

Background

The lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside and watching TV have been indicated to have an association with childhood overweight, but research among young children (below 6 years old) is limited. The aim of the present study was to assess the associations between these four behaviors and overweight among young children.

Methods

This cross-sectional study used baseline data on 5-year-old children (n = 7505) collected for the study 'Be active, eat right'. Age and sex-specific cut-off points for body mass index of the International Obesity Task Force were used to assess overweight/obesity. Multivariable logistic regression analyses were applied.

Results

For children whom had breakfast <7 days/week and watched TV >2 hours/day, the odds ratio (OR) for having overweight (obesity included) was, respectively, 1.49 (95% confidence interval (CI): 1.13-1.95), and 1.25 (95% CI: 1.03-1.51). There was a positive association between the number of risk behaviors present and the risk for having overweight. For children with 3 or all of the risk behaviors having breakfast <7 days/week, drinking sweet beverages >2 glasses/day, playing outside <1 h/day, watching TV >2 hs/day, the OR for overweight was 1.73 (95% CI: 1.11-2.71) (all models adjusted for children's sex and sociodemographic characteristics).

Conclusion

Given the positive association between the number of behavioral risk factors and overweight, further studies are needed to evaluate the effectiveness of behavioral counseling of parents of toddlers in preventing childhood overweight. In the meantime we recommend physicians to target all four behaviors for counseling during well-child visits.

BACKGROUND

Over the last few decades, an epidemic of childhood overweight and obesity occurred worldwide.[1-5] Nearly 43 million children under the age of 5 years were overweight globally in 2010.[4] An important step in successful prevention in pediatrics is the identification of modifiable risk factors of childhood overweight; such risk factors may be important targets for counseling of parents during well-child or pediatric visits to contribute to the prevention of overweight and obesity.[6-8] Overweight is caused fundamentally by an imbalance between energy intake and energy expenditure.[1, 4, 9] The lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside and watching TV have been indicated to have an association with childhood overweight.[10-14] The research in which these associations were investigated, included mainly school-aged children. Research among younger children (below 6 years old) is limited.[8, 15, 16] In studies that did include this young age-group, associations that were found were unclear due to conflicting results and differences in methodology between studies, for example differences in measurement of behavior and adjustment for confounders.[8, 16-27] Furthermore, the analyses that were used were primarily simple or bivariate, while risk factors are likely to interact with each other.[6, 7] Therefore, more research in early childhood is needed in which large study populations are included,[15] and in which multiple behavioral risk factors for childhood overweight are investigated.

The aim of the present study was to assess the associations between the four lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside and watching TV, and overweight in a large sample of 5-year-old children. In addition, as it is likely that the risk behaviors coexist, the association between the number of risk behaviors that is present and overweight (obesity included) was investigated.

METHODS

Design and study population

The present cross-sectional study was embedded in the 'Be active, eat right' study, which aims to assess the effects of an overweight prevention protocol, as described in detail elsewhere.[28] The Medical Ethics Committee of Erasmus MC University Medical Centre Rotterdam approved the study protocol. A total of 13 638 parents of 5-year-olds were invited by mail for a well-child visit (which has an attendance rate of 95%)[29] at one of the nine municipal health services across the Netherlands participating in the study. These parents were also invited to participate in the 'Be active, eat right' study, 64.4% of whom provided written informed consent. Baseline data were collected during the 2007–2008 school year, and these data were used for the present study. Parents completed a questionnaire with items on demographic,

socioeconomic, and lifestyle-related characteristics of themselves and their child. Height and weight of the children were measured by trained health care professionals during well-child visits.

Data of children and their parents were excluded from analyses when data were missing on height or weight of the child (n = 34), sex or age of the child (n = 107), ethnicity of the child (n = 75), the lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside or watching TV by the child (n = 933), sex or age of the parent (n = 13), educational level of the parent (n = 49), employment status of the parent (n = 52) or single parenting (n = 16). After exclusion for these reasons, a study population of n = 7505 remained.

Lifestyle-related behaviors

We obtained information on the four lifestyle-related behaviors of the children by a questionnaire completed by the parents. The parents reported, for an average week, how many days per week their child has breakfast, the number of sweet beverages (i.e. lemonade, soda, carbonated soda, fruit juice, sugar sweetened dairy products, etc.) their child drinks per day, the duration of outdoor playing time of their child per day, and the amount of time their child watches TV per day. Risk behaviors were defined as having breakfast <7 days/week, drinking sweet beverages >2 glasses/day, playing outside <1 hour/day and watching TV >2 hours/day. The definitions of these risk behaviors are based on international recommendations.[11-13, 30-32]

Weight status of the children

Body weight and height of the children were measured by trained health care professionals during well-child visits using standardized methods as described in a protocol.[33] Body weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm. Body mass index (BMI) was calculated by dividing weight (in kilograms) by height (in meters) squared. The weight status of the children was assessed according to the age and sex-specific cut-off points for BMI as published by the International Obesity Task Force.[34] When the BMI value of a child was the same as or higher than the cut-off point for overweight or obesity for the child's age and sex, the child was defined as having overweight or obesity.

Sociodemographic characteristics

We obtained information on sociodemographic characteristics by a questionnaire completed by the parents. We considered the sociodemographic characteristics sex and ethnicity (Dutch, non-Dutch) of the child, educational level (high level, mid level, low level) of the parent, employment status (employed full-time or part-time, not employed) of the parent, and single parenthood (two-parent families, single-parent family or otherwise specified) potential confounders in the association between the behaviors and having overweight or obesity of the children.[15] A child was considered to be of non-Dutch ethnicity when at least

one of the parents was born abroad, as defined by Statistics Netherlands.[35] Educational level of the parent was recoded in three categories, according to the Dutch standard classification as defined by Statistics Netherlands:[36] high level (academic higher education/university education, higher professional education), mid level (pre-university education, senior general secondary education, and senior secondary vocational education), and low level (preparatory secondary vocational education, lower secondary vocational education, primary education, and no education).

Statistical analysis

We examined mean and frequency differences of the sociodemographic characteristics of the parents and their children, and children's behaviors, between the groups of children with and without overweight (obesity included) using t tests for continuous variables and Chi-square statistics for categorical variables. We used multivariable logistic regression analyses to test the associations between the child's behaviors and overweight (obesity included) of the child, and we obtained odds ratios (ORs) and 95% confidence intervals (CIs).

In the first model we investigated the associations between each behavior individually and overweight of the children. In the second model we included all four behaviors of the children. Further, we estimated the odds of having overweight (obesity included) associated with having one, two, or three or all of the risk behaviors relative to having none of the risk behaviors. All analyses were adjusted for sociodemographic characteristics.

We examined whether there was interaction between sex and the behaviors in the association with overweight (obesity included) among the children. However, we found no effect modification, so stratification of the analyses was not necessary, but we adjusted all models for sex of the child. We performed the statistical analyses using PASW Statistics 17 for Windows (SPSS Inc, Chicago, IL). We also investigated the associations using multilevel logistic regression, to take into account the clustering of the children within teams of health care professionals. In addition, the intra-cluster correlation coefficient (ICC) was calculated for weight status of the children to investigate the proportion of the within-cluster variance in the total variance among the children.[37] These analyses were performed using SAS software (version 9.2; SAS Institute Inc, Cary, North Carolina). The ICC appeared to be relatively small (0.01) and the results of the multilevel analyses did not differ significantly from the results of the logistic regression analyses. Therefore, we concluded that the clustering of the children within the teams of health care professionals did not affect the results of this study, and we reported the results of the logistic regression analyses without the multilevel component.

RESULTS

The prevalence of overweight (obesity included) among the children was 8.8%. Of all included children, mean age was 5.7 (SD 0.4) years, 50.9% were boys, and 13.9% were of non-Dutch ethnicity, 6.5% did not have breakfast daily, 64.3% drank >2 glasses of sweet beverages/day, 6.5% played outside <1 hour/day, and 19.1% watched TV >2 hours/day. In 21.1% of the children, 2 or more of the risk behaviors were present (the sum of the frequencies 'any 2' and 'any 3 or all'). All sociodemographic characteristics of the parents and children, and lifestyle-related characteristics of the children differed statistically significant between the subgroups of children with and without overweight (obesity included), with the exception of sex of the parent who completed the questionnaire, age of the child, and the amount of time the child played outside (Table 6.1).

Table 6.1 Characteristics of the total study population and according to children's weight status (n = 7505)

	Frequency in study population (%) (unless otherwise specified)			
	Total	**Child has overweight (obesity included)[a]**		***P*-value[b]**
		No (n = 6847)	**Yes (n = 658)**	
Parent characteristics				
Mean age, years (SD)	36.8 (4.5)	36.9 (4.5)	36.3 (4.8)	<.01
Mother is respondent	6639 (88.5)	6055 (88.4)	584 (88.8)	.81
Low educational level[c]	1470 (19.6)	1274 (18.6)	196 (29.8)	<.001
Not employed	1888 (25.2)	1699 (24.8)	189 (28.7)	<.05
Single parent	506 (6.7)	437 (6.4)	69 (10.5)	<.001
Child characteristics				
Mean age, years (SD)	5.7 (0.4)	5.7 (0.4)	5.8 (0.4)	.22
Boy	3820 (50.9)	3567 (52.1)	253 (38.4)	<.001
Non-Dutch ethnicity	1044 (13.9)	909 (13.3)	135 (20.3)	<.001
Mean BMI (SD)	15.5 (1.5)	15.2 (1.1)	18.7 (1.4)	<.001
Child risk behaviors				
Having breakfast <7 days/week	488 (6.5)	415 (6.1)	73 (11.1)	<.001
Drinking sweet beverages >2 glasses/day	4826 (64.3)	4377 (63.9)	449 (68.2)	<.05
Playing outside <1 h/day	486 (6.5)	445 (6.5)	41 (6.2)	.79
Watching TV >2 hs/day	1430 (19.1)	1261 (18.4)	169 (25.7)	<.001
Number of child risk behaviors present				
None	2059 (27.4)	1922 (28.1)	137 (20.8)	<.001
Only 1	3686 (51.5)	3530 (51.6)	338 (51.4)	
Any 2	1386 (18.5)	1231 (18.0)	155 (23.6)	
Any 3 or all	192 (2.6)	164 (2.4)	28 (4.3)	

[a]According to the age and sex specific cut-off points for BMI as published by the IOTF.[34]

[b]P-value for difference between overweight no/yes.

[c]Low education level = no education, primary education, lower secondary vocational education, and preparatory secondary vocational education.

Table 6.2 Associations between the behaviors and overweight (obesity included) among the children (n = 7505)

	Prevalence of overweight (obesity included)[a]		OR (95% CI)	
		P-value[b]	Model 1	Model 2
Having breakfast				
7 days/week	8.3	<.001	1.00	1.00
<7 days/week	15.0		1.49 (1.13 – 1.95)	1.44 (1.09-1.89)
Drinking sweet beverages				
≤2 glasses/day	7.8	<.05	1.00	1.00
>2 glasses/day	9.3		1.17 (0.99-1.40)	1.15 (0.97-1.38)
Playing outside				
≥1 h/day	8.8	.79	1.00	1.00
<1 h/day	8.4		0.98 (0.70-1.37)	0.98 (0.70-1.37)
Watching TV				
≤2 hs/day	8.0	<.001	1.00	1.00
>2 hs/day	11.8		1.25 (1.03-1.51)	1.20 (0.98-1.46)

Model 1: behaviors individually.

Model 2: all behaviors included simultaneously.

All analyses were adjusted for sex of the child and sociodemographic characteristics (child's ethnicity, educational level parent, single parenthood, job status of the parent).

[a]According to the age and sex specific cut-off points for BMI as published by the IOTF.[34]

[b]P-value for difference in prevalence of overweight (obesity included) between child risk behavior not present/present.

Compared to the children whom had breakfast every day, children whom did not eat breakfast daily were more likely to have overweight (obesity included) (OR = 1.49, 95% CI: 1.13-1.95, adjusted for confounders). Compared to the children whom watched TV ≤2 hours/day, the OR for having overweight (obesity included) was 1.25 (95% CI: 1.03-1.51, adjusted for confounders) for children whom watched TV >2 hours/day. After including the four behaviors in the model simultaneously, only the association between not having breakfast daily and overweight remained statistically significant (OR = 1.44, 95% CI: 1.09-1.89) (Table 6.2).

The number of risk behaviors that were present, was positively associated with having overweight (obesity included), and compared to children with none of the risk behaviors, the OR for having overweight was 1.73 for children with 3 or all behaviors (95% CI: 1.11-2.71, adjusted for confounders) (Table 6.3).

Table 6.3 Association between number of risk behaviors and overweight (obesity included) (n = 7505)

Number of child risk behaviors[a]	OR (95% CI)
None	1.00
Only 1	1.31 (1.06-1.61)
Any 2	1.48 (1.15-1.89)
Any 3 or all	1.73 (1.11-2.71)

All analyses were adjusted for sex of the child and sociodemographic characteristics (child's ethnicity, educational level parent, single parenthood, job status of the parent).

[a]The 4 child risk behaviors were 1) playing outside <1 h/day, 2) having breakfast <7 days/week, 3) drinking sweet beverages >2 glasses/day, and 4) watching TV >2 hs/day.

DISCUSSION

We assessed the associations between the four lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside and watching TV, and overweight among 5-year-old children. The results indicate that not having breakfast daily and spending too much time watching TV are behavioral risk factors for having overweight (obesity included) already at this young age. We also found that not having breakfast every day is a risk factor independent of the other lifestyle-related behaviors. Further, we found that having multiple of the investigated behavioral risk behaviors (not having breakfast daily; drinking >2 glasses of sweet beverages; spending <1 hour playing outside; and spending >2 hours watching TV per day) is associated with an increased risk of having overweight (obesity included) in early childhood.

With the results of our study we further strengthen the literature base regarding the four behavioral risk factors for overweight in early childhood.[17-26, 38] We add to the existing knowledge as we included a large study population of young children (n = 7505) with a small age range, so our results could be specifically ascribed to the 5-year-old age group. Further, we included both dietary and physical activity factors, and also took important sociodemographic characteristics like socioeconomic status (SES) and ethnicity into account. We have extended the findings of previous studies by examining how the number of risk behaviors present is associated with the risk of having overweight during early childhood. Although the four risk factors assessed in this study are of practical relevance for guiding well-child visits, we are not aware of the impact of behaviors not included in the study such as consumption of sweet and savory snacks; neither did we include a food frequency questionnaire nor a full assessment of physical activity and sedentary behaviors.

Compared to the data of children/parents with missing data (n = 1279), the population analyzed (n = 7505) included statistically significant less children of non-Dutch ethnicity (P < .001), less children with overweight or obesity (P < .01), less children with the risk behav-

iors not having breakfast daily (P < .001) and watching TV >2 hours per day (P < .001), and more parents with a high educational level (P < .001), more parents that were employed (P < .001), and less single parents (P < .001). Thus, there was some selection towards a study population in which the children more often were of Dutch ethnicity, had a higher SES, had a healthier lifestyle and less often had overweight. So, the prevalence of the risk behaviors and overweight in this study might therefore be somewhat underestimated. However, although we cannot ascertain this, it is unlikely that the associations between risk behaviors and overweight in the study population differ from those in the source population.

Another methodological consideration that needs to be addressed is that the characteristics of the parent and the child were based on self-reported data of the parent, and although anonymity was assured, parents might have given socially desirable answers. Height and weight of the children was, however, measured by trained health care professionals during well-child visits.

In addition to the main logistic regression analyses, in which the behaviors were included as dichotomous variables (risk behavior present or not, based on international recommendations), we also investigated the associations with the behaviors divided into more categories. Overall, the results of these analyses did not differ significantly compared to the results of the main analyses. However, children whom had breakfast less than 5 days a week appeared to have no statistically significant increased risk for having overweight (obesity included). On the other hand, for watching TV the ORs in the fully adjusted model remained statistically significant when watching TV less than 1 hour was used as the reference category (see Appendix 6.1). Further, we also performed multinomial logistic regression analyses to distinguish between the associations of the risk behaviors with children's overweight, and their associations with children's obesity. The association between not having breakfast daily and having overweight remained statistically significant. Watching TV more than recommended appeared to be a risk factor for having obesity, independent of the other lifestyle-related behaviors (see Appendix 6.2). We also performed an analysis in which we distinguished the subgroup obesity further in obesity versus severe obesity. While there are currently no international BMI cut-off points for severe obesity, we used the following cut-off points based on recent literature on this topic[13] and sample size considerations; for boys ≥20 (kg/m^2) and for girls ≥21 (kg/m^2). The results show that watching TV was no longer statistically significant associated with the risk of having obesity (n = 63), but there was a strong association with having severe obesity (n = 63); compared to children whom watched TV ≤2 hs/day, for children whom watched TV >2 h/day the OR was 2.14 (95% CI: 1.26-3.63) (data not shown). On the whole, these findings indicate that there are differences in associations between lifestyle-related behavior and weight status of children for different stages of overweight. We also investigated the associations with the behaviors playing outside and watching TV

included in the model as continuous variables. Since these variables did not have a normal distribution, we used the log transformations of these variables. We found that when watching TV increases with a factor of 10, that the risk of having overweight (obesity included) increases with an OR of exp(0.46) (95% CI: 0.20-0.72). For playing outside the increase in OR is exp(0.36) (95% CI: 0.03-0.69) (data not shown). More research is needed to investigate the latter association, as it is not as expected that more time playing outside is associated with a higher risk for having overweight. However, no statistical significant association was found for this behavior in the main or other analyses.

As we used cross-sectional data, the direction of the associations we found can not be confirmed. Spending too much time watching TV might increase the risk for developing obesity, but obese children might also increase the time their watching TV as a consequence of their weight status. For having breakfast, it might be the case that parents let their children skip this meal as a strategy to control the children's weight, but not much is known from literature about such a mechanism among such young children.[39] It is however more likely that, also considering the age of the children, the skipping breakfast contributed to the excess weight gain and not the other way around. It is known from literature that children whom do not eat breakfast, are more likely to consume unhealthy foods during the day,[39] which induces the development of overweight.

In the main logistic regression analyses, we did not found a statistical significant association between the behaviors playing outside or drinking sweet beverages, and the risk for having overweight or obesity at the age of 5 years. An association between these behaviors and having overweight or obesity is likely to appear among the study population when they are getting older. The small average daily energy imbalance that is caused by spending too little time playing outside and drinking too much sweet beverages per day, probably needs to have sustained for several years before an effect on weight can be detected in our study population.[17, 23] Further, as also indicated by previous literature, behavioral risk factors tend to cluster together. The association between one behavior and the risk for having overweight might be too weak to appear in statistical analyses, but when multiple of these behaviors are present the effects of these behavioral risk factors might do appear.[6, 7, 13] We indeed found that with an increasing number of risk behaviors present, the risk for having overweight (obesity included) was also higher. There are several ways in which the four lifestyle-related behaviors might be correlated with and influence one another, and which may also contribute to the apparent increased risk for having overweight when multiple of the behaviors are present. We already mentioned the higher intake of unhealthy, energy dense foods during the day, like sweet beverages, among children whom do not eat breakfast daily.[39] Another mechanism is a potential increase in intake of these unhealthy foods while watching TV or through advertising for these foods, and through food messages embedded within program content.[6,

[7, 21, 23, 40] Further, the time children spent watching TV might displace time spent in physical activity.[6, 7]

CONCLUSIONS

Not having breakfast daily and watching TV more than recommended appeared to be risk factors for having overweight (obesity included), already during early childhood. Further, when the number of the risk behaviors (risk behaviors investigated: not having breakfast every day, drinking >2 glasses of sweet beverages, and spending <1 hour playing outside and >2 hours watching TV per day) in these young children increased, also the risk for having overweight increased. This confirms current knowledge among older children that all four risk behaviors are associated with the presence of overweight. It is likely that risk behaviors present in early childhood tend to persist during school age and even adolescence.[6, 8] Therefore we recommend studies to develop, implement and evaluate the effectiveness of educational interventions that tackle obesogenic lifestyles during early childhood in order to prevent the onset of overweight and obesity when the children grow up. In the meantime we recommend physicians to target all four behaviors, and especially having breakfast and watching TV, for counseling during well-child visits before adverse habits are established.

REFERENCES

1. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet*. 2002;360(9331):473-482.
2. Krebs NF, Jacobson MS, American Academy of Pediatrics. Committee on Nutrition: Prevention of pediatric overweight and obesity. *Pediatrics*. 2003;112(2):424-430.
3. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
4. World Health Organization. Factsheet N⁰311, Obesity and overweight. February 2011. [http://www.who.int/mediacentre/factsheets/fs311/en/](N0311).
5. Cattaneo A, Monasta L, Stamatakis E, Lioret S, Castetbon K, Frenken F, et al. Overweight and obesity in infants and pre-school children in the European Union: a review of existing data. *Obes Rev*. 2009;11(5):389-398. Epub 2009 Jul 2010.
6. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord*. 1999;23 Suppl 8:S1-107.
7. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev*. 2001;2(3):159-171.
8. Hawkins SS, Law C. A review of risk factors for overweight in preschool children: a policy perspective. *Int J Pediatr Obes*. 2006;1(4):195-209.
9. Lustig RH. The neuroendocrinology of childhood obesity. *Pediatric clinics of North America*. 2001;48(4):909-930.
10. Whitaker RC. Obesity prevention in pediatric primary care: four behaviors to target. *Arch Pediatr Adolesc Med*. 2003;157(8):725-727.
11. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.
12. Davis MM, Gance-Cleveland B, Hassink S, Johnson R, Paradis G, Resnicow K. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007;120 Suppl 4:S229-253.
13. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-192.
14. Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. *Current opinion in clinical nutrition and metabolic care*. 2007;10(3):336-341.
15. Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *International journal of obesity (2005)*. 2005;29 Suppl 2:S84-96.
16. Wareham NJ, van Sluijs EM, Ekelund U. Physical activity and obesity prevention: a review of the current evidence. *The Proceedings of the Nutrition Society*. 2005;64(2):229-247.
17. Burdette HL, Whitaker RC. A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics*. 2005;116(3):657-662.
18. Salmon J, Campbell KJ, Crawford DA. Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. *Med J Aust*. 2006;184(2):64-67.
19. Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by-environment interaction. *Pediatrics*. 2006;118(5):2066-2075.

20. Dubois L, Girard M, Potvin Kent M. Breakfast eating and overweight in a pre-school population: is there a link? *Public Health Nutr*. 2006;9(4):436-442.
21. Lumeng JC, Rahnama S, Appugliese D, Kaciroti N, Bradley RH. Television exposure and overweight risk in preschoolers. *Arch Pediatr Adolesc Med*. 2006;160(4):417-422.
22. Blair NJ, Thompson JM, Black PN, Becroft DM, Clark PM, Han DY, et al. Risk factors for obesity in 7-year-old European children: the Auckland Birthweight Collaborative Study. *Archives of disease in childhood*. 2007;92(10):866-871.
23. Dubois L, Farmer A, Girard M, Peterson K. Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool-aged children. *J Am Diet Assoc*. 2007;107(6):924-934; discussion 934-925.
24. Spinks AB, Macpherson AK, Bain C, McClure RJ. Compliance with the Australian national physical activity guidelines for children: relationship to overweight status. *Journal of science and medicine in sport / Sports Medicine Australia*. 2007;10(3):156-163.
25. Utter J, Scragg R, Schaaf D, Fitzgerald E, Wilson N. Correlates of body mass index among a nationally representative sample of New Zealand children. *Int J Pediatr Obes*. 2007;2(2):104-113.
26. Cleland V, Crawford D, Baur LA, Hume C, Timperio A, Salmon J. A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *International journal of obesity (2005)*. 2008;32(11):1685-1693.
27. Must A, Barish EE, Bandini LG. Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children? *International journal of obesity (2005)*. 2009;33(7):705-715.
28. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, et al. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC public health*. 2009;9:177.
29. Renders CM, Halberstadt J, Frenkel CS, Rosenmoller P, Seidell JC, Hirasing RA. Tackling the problem of overweight and obesity: the dutch approach. *Obesity facts*. 2010;3(4):267-272. Epub 2010 Aug 2013.
30. American Academy of Pediatrics. Committee on Public Education: Children, adolescents, and television. *Pediatrics*. 2001;107(2):423-426.
31. American Academy of Pediatrics. Committee on Nutrition: The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001;107(5):1210-1213.
32. Commonwealth Department of Health and Ageing. Australia's physical activity recommendations for 5-12 year kids. Canberra: Commonwealth of Australia. Available from: http://www.health.gov.au/internet/main/publishing.nsf/Content/9D7D393564FA0C42CA256F970014A5D4/$File/kids_phys.pdf; 2004.
33. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Signaleringsprotocol Overgewicht in de Jeugdgezondheidszorg [Youth Health Care Overweight-detection-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; November 2004.
34. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed*. 2000;320(7244):1240-1243.
35. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. 2004. Available from: http://www.cbs.nl/nl-NL/menu/themas/bevolking/publicaties/publicaties/archief/2004/2004-b52-pub.htm.

36. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Standaard Onderwijsindeling 2003 [The Dutch Standard Classification of Education]. 2004. Available from: http://www.cbs.nl/nl-NL/menu/methoden/classificaties/overzicht/soi/2003/default.htm.
37. Twisk JWR. *Applied Multilevel Analysis: A Practical Guide*. Cambridge: Cambridge University Press; 2006.
38. Lim S, Zoellner JM, Lee JM, Burt BA, Sandretto AM, Sohn W, et al. Obesity and sugar-sweetened beverages in African-American preschool children: a longitudinal study. *Obesity (Silver Spring, Md*. 2009;17(6):1262-1268.
39. Utter J, Scragg R, Mhurchu CN, Schaaf D. At-home breakfast consumption among New Zealand children: associations with body mass index and related nutrition behaviors. *J Am Diet Assoc*. 2007;107(4):570-576.
40. Dubois L, Farmer A, Girard M, Peterson K. Social factors and television use during meals and snacks is associated with higher BMI among pre-school children. *Public Health Nutr*. 2008;11(12):1267-1279.

APPENDIX

Appendix 6.1 Associations between behaviors and overweight, with the behaviors divided in >2 categories (n = 7505)

	Prevalence of overweight (obesity included)[a]		OR (95% CI)	
		P-value[b]	Model 1	Model 2
Having breakfast				
7 days/week (n = 7017)	8.3	<.001	1.00	1.00
≥5 - <7 days/week (n = 317)	14.2		1.51 (1.08 – 2.10)	1.47 (1.05 – 2.05)
<5 days/week (n = 171)	16.4		1.45 (0.94 – 2.23)	1.37 (0.89 – 2.11)
Drinking sweet beverages				
<1 à 2 glasses/day (n = 306)	8.2	.10	1.00	1.00
≥1 à 2 - <4 à 5 glasses/day (n = 6010)	8.5		1.09 (0.71 – 1.66)	1.09 (0.71 – 1.67)
≥4 à 5 - <7 à 8 glasses/day (n = 1062)	10.3		1.23 (0.78 – 1.95)	1.18 (0.74 – 1.87)
≥7 à 8 glasses/day (n = 127)	12.6		1.33 (0.68 – 2.61)	1.27 (0.65 – 2.51)
Playing outside				
≥2 h/day (n = 4185)	9.5	.08	1.00	1.00
≥1 - 2 h/day (n = 2834)	7.7		0.84 (0.71 – 1.00)	0.86 (0.72 – 1.03)
<1 - ≥0.5 h/day (n = 429)	8.4		0.93 (0.65 – 1.34)	0.96 (0.66 – 1.38)
<0.5 h/day (n = 57)	8.8		0.81 (0.32 – 2.07)	0.87 (0.34 – 2.22)
Watching TV				
<1 h/day (n = 1743)	6.3	<.001	1.00	1.00
≥1 - <2 hs/day (n = 3985)	8.7		1.33 (1.06 – 1.66)	1.32 (1.05 – 1.65)
≥2 - <3 hs/day (n = 1269)	10.7		1.44 (1.10 – 1.89)	1.38 (1.05 – 1.81)
>3 hs/day (n = 508)	13.0		1.60 (1.14 – 2.24)	1.47 (1.04 – 2.07)

Model 1: behaviors individually.

Model 2: all behaviors included simultaneously.

All analyses were adjusted for sex of the child and sociodemographic characteristics (child's ethnicity, educational level parent, single parenthood, job status of the parent).

[a]According to the age and sex specific cut-off points for BMI as published by the IOTF.[34]

[b]P-value for difference in prevalence of overweight (obesity included) between categories of child behavior.

Appendix 6.2 Associations between behaviors and weight status, for subgroups overweight and obesity separately (n = 7505)

	Overweight (n = 532)			
	Prevalence of overweight[a]		OR (95% CI)	
		P-value[b]	Model 1	Model 2
Having breakfast				
7 days/week	6.9	<.001	1.00	1.00
<7 days/week	11.9		1.46 (1.07-1.97)	1.42 (1.05-1.93)
Drinking sweet beverages				
≤2 glasses/day	6.4	<.05	1.00	1.00
>2 glasses/day	7.7		1.19 (0.98-1.44)	1.17 (0.97-1.42)
Playing outside				
≥1 h/day	7.2	.94	1.00	1.00
<1 h/day	7.3		1.03 (0.72-1.47)	1.03 (0.72-1.47)
Watching TV				
≤2 hs/day	6.8	<.01	1.00	1.00
>2 hs/day	9.0		1.14 (0.92-1.42)	1.10 (0.88-1.37)
	Obesity (n = 126)			
	Prevalence of obesity[a]		OR (95% CI)	
		P-value[b]	Model 1	Model 2
Having breakfast				
7 days/week	1.7	<.001	1.00	1.00
<7 days/week	3.9		1.60 (0.93-2.73)	1.48 (0.86-2.54)
Drinking sweet beverages				
≤2 glasses/day	1.6	.32	1.00	1.00
>2 glasses/day	1.9		1.13 (0.77-1.66)	1.07 (0.73-1.58)
Playing outside				
≥1 h/day	1.8	.43	1.00	1.00
<1 h/day	1.3		0.76 (0.33-1.75)	0.77 (0.34-1.78)
Watching TV				
≤2 hs/day	1.4	<.001	1.00	1.00
>2 hs/day	3.4		1.71 (1.16-2.53)	1.65 (1.11-2.44)

Reference category is 'no overweight'.

Model 1: behaviors individually.

Model 2: all behaviors included simultaneously.

All analyses were adjusted for sex of the child and sociodemographic characteristics (child's ethnicity, educational level parent, single parenthood, job status of the parent).

[a]According to the age and sex specific cut-off points for BMI as published by the IOTF.[34]

[b]*P*-value for difference in prevalence of overweight/obesity between child risk behavior not present/present.

7

Parenting style, the home environment, and screen time of 5-year-old children; the 'Be active, eat right' study

Lydian Veldhuis
Amy van Grieken
Carry M. Renders
Remy A. HiraSing
Hein Raat

Submitted for publication

ABSTRACT

Introduction

The global increase in childhood overweight and obesity has been ascribed partly to increases in children's screen time. Parents have a large influence on their children's screen time. Studies investigating parenting and early childhood screen time are limited. In this study, we investigated associations of parenting style and the social and physical home environment on watching TV and using (game) computers among 5-year-old children.

Methods

This study uses baseline data concerning 5-year-old children (n = 3067) collected for the 'Be active, eat right' study. Parents provided questionnaire information on sociodemographic characteristics, children's screen time, the home environment, and parenting style.

Results

Children of parents with a higher score on the parenting style dimension involvement, were more likely to spend >30 min/day on (game) computers. Overall, families with an authoritative or authoritarian parenting style had lower percentages of children's screen time compared to families with an indulgent or neglectful style, but no significant difference in OR was found. In families with rules about screen time, children were less likely to watch TV >2 hrs/day and more likely to spend >30 min/day on (game) computers. The number of TVs and (game) computers in the household was positively associated with screen time, and children with a TV or (game) computer in their bedroom were more likely to watch TV >2 hrs/day or spend >30 min/day on (game) computers.

Conclusion

The magnitude of the association between parenting style and screen time of 5-year-olds was found to be relatively modest. The associations found between the social and physical environment and children's screen time are independent of parenting style. Interventions to reduce children's screen time might be most effective when they support parents specifically with introducing family rules related to screen time and prevent the presence of a TV or (game)computer in the child's room.

INTRODUCTION

The global increase in prevalence of childhood overweight and obesity has been ascribed to several trends including the increase in consumption of energy-dense diets and the increase in sedentary behavior (in particular the increase in screen time; time spent watching TV and on (game) computers).[1-3] Children's screen time increases with age and patterns of screen time track over time.[4, 5] Parents influence their children's screen time by their practices (e.g. having rules about watching TV) and by controlling the physical home environment (e.g. placing or not allowing a TV in the child's bedroom).[1, 6]

Interventions aiming to reduce children's screen time should be family-based, start during early childhood, and target modifiable factors in the home setting.[1, 7] It is likely that the home environment factors that influence children's screen time, and their impact on screen time, change during childhood.[4, 8] Most studies investigating associations between the social and physical home environment and children's screen time included school-aged children (between the age of 6 to 13 years);[4, 9-18] studies investigating these associations in children below 6 years of age are limited.[19-21] Previous studies found that family rules on watching TV are associated with less TV viewing[10, 13, 14, 20] and that high child autonomy is associated with more TV viewing.[9, 15] The results of studies investigating the influence of having a TV in the child's bedroom on the amount of TV viewing are inconsistent; some studies found that a TV in the child's bedroom was associated with increased TV viewing[12, 14, 16, 19, 22] whereas others found no association.[4, 10, 11, 15] Further, most studies included only watching TV as a screen time activity and only few studies included using (game) computers as screen time.[15, 18, 20, 22]

Parenting practices and parenting decisions on the physical home environment take place in the context of the parenting style (i.e. the climate in which a family functions and children are raised).[8, 23] Parenting style can be categorized as authoritative, authoritarian, indulgent, or neglectful.[24] However, the relationships between parenting style, the social and physical home environment and children's screen time remain (largely) unknown.[25-27]

The relationships between parenting style, the home environment, and children's screen time and weight status are complex. It is unclear how parenting style and the home environment are associated with young children's screen time. In this study, we investigated associations between parenting style, the home environment and screen time among a large sample of 5-year-old children (Figure 7.1; the association with children's weight status is outside of the scope of the present study). First, we hypothesized that screen time would be lower for children of parents with higher scores on strictness in general (parents with an authoritarian or authoritative parenting style) (arrow A in Figure 7.1). Second, we hypothesized that children's screen time would be the lowest for children in families with rules regarding screen time and

would be the highest for children with a TV or (game) computer in their bedroom (arrow B in Figure 7.1). Thirdly, we also examined whether the association between parenting style and children's screen time was mediated through the home environment (arrow C and B in Figure 7.1).

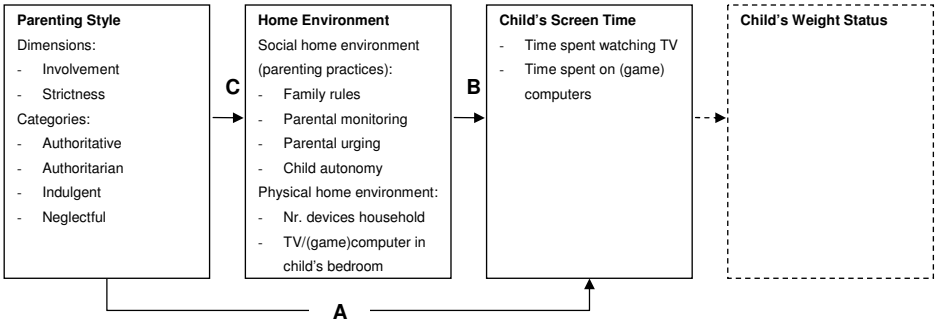

Figure 7.1 Hypothesized model of relationships between parenting style, home environment, children's screen time and weight status

METHODS

Design and study population

This study is embedded in the 'Be active, eat right' study. As detailed elsewhere,[28] the 'Be active, eat right' study aims to assess the effects of an overweight prevention program among children at elementary schools throughout the Netherlands. The Medical Ethics Committee of the Erasmus MC - University Medical Centre Rotterdam approved the study protocol. Of the 37 municipal health services in the Netherlands, nine municipal health services agreed to participate in the study. A total of 13,638 parents of 5-year-olds were invited by mail for a free-of charge well-child visit at one of these nine municipal health services and 64.4% (n = 8784) provided written informed consent to participate in the study. The children and their parents were randomly allocated into either an intervention group or a control group. Baseline data were collected during the 2007-2008 school year and these data were used for the present study.

Parents completed questionnaires with items on socio-demographic characteristics and lifestyle-related characteristics pertaining to themselves and their child. To minimize the respondent burden, only a subgroup (n = 4381) of the total population (n = 8784) included in the study was asked to complete an additional questionnaire. This additional questionnaire included items on parenting style, and the social and physical home environment. All parents in the control group were asked to complete this questionnaire (n = 3942) whereas

only parents of children with overweight or obesity in the intervention group were asked to complete the questionnaire (n = 439).[28] The questionnaire was developed based on items used in other studies on screen time, parenting style, and social and physical home environment characteristics.[29-31] The response rate for the questionnaire was 74.8% (n = 3278). After removing records with missing data on the child's screen time (n = 211), a study population of n = 3067 children and their parents remained.

Screen time of the children

Parents reported on a questionnaire the time their child spent watching TV and using a (game) computer. We indicated in the questionnaire that a (game) computer also included portable consoles. Parents were asked to indicate the average number of weekdays and weekend days their child spent time on a (game) computer and watching TV, and how much time their child spent on a (game) computer and watched TV on average in the morning, the afternoon, and at night after dinner on weekdays and during weekends. We combined the weekday and weekend data and recoded the two screen time variables. To dichotomize using (game) computers, we used 30 minutes per day (min/day) as the cut-off point to allow meaningful comparisons between subgroups that spent ≤30 min/day versus >30 min/day on (game) computers (approximately 15% of the children spent >30 min/day on (game) computers; <5% spent >1 hour/day on (game) computers). Watching TV was dichotomized based on international recommendations[32-34] into watching TV ≤2 hours per day (hrs/day) or >2 hrs/day.

Parenting style

Parenting style was assessed using an adapted version of the Steinberg instrument, which is considered one of the best measurement tools available to measure parenting style.[8, 24, 29] Two parenting style dimensions were measured: involvement and strictness of the parents in general. The involvement and strictness scales included nine and six items, respectively. Parents responded on a 5-point scale with the scale ranging from strongly agree to strongly disagree. Internal consistencies were $\alpha = 0.75$ for the involvement scale and $\alpha = 0.78$ for the strictness scale. A full description of scales, scale properties, items, and item response scales is available in Appendix 7.1.

In the main analyses, we used the continuous parenting style dimensions involvement and strictness.[35] The involvement and strictness scales can be used to define four parenting styles: authoritative (high on involvement and high on strictness), authoritarian (low on involvement and high on strictness), indulgent (high on involvement and low on strictness) and neglectful (low on involvement and low on strictness). For interpretation purposes we categorized parents into the four styles by using the median splits on both the involvement and strictness scales.[24]

Social environment and physical home environment

The following parenting practices (i.e. the social environment) regarding screen time were measured: family rules regarding screen time, parental monitoring of their child's screen time, whether the parents urge their child to turn off the TV or (game) computer, and the autonomy of the child regarding screen time. A 'rules' index was created by summing the number of rules, with a higher score indicating that the parents had more rules with regard to their child's screen time. Parental monitoring and urging to turn off the TV or (game) computer were assessed using a 5-point response scale. A higher score on each of these items indicated that the parents monitor their child's screen time and urge their child to turn off the TV or (game) computer. Child autonomy was assessed using three items. A scale was created, with higher scores indicating more autonomy of the child concerning screen time.

The physical home environment was measured using two items; the number of TVs and (game) computers present in the household, and whether the child has a TV or (game) computer in his or her bedroom.

A full description of scales, scale properties, items, and item response scales is available in Appendix 7.1. No strong correlations were found between the factors measuring the social environment and physical environment (all correlations below 0.80), and therefore there are no indications for multicollinearity.

Sociodemographic characteristics

We included several potential confounding sociodemographic characteristics in this study: child sex and the child's ethnic background (Dutch, non-Dutch), parental educational level (high, mid, or low), family structure (two-parent family, single-parent family or other), and parental employment status (employed full-time/part-time or not employed). A child was considered to be of non-Dutch ethnic background when at least one of the parents was born abroad (definition as used by Statistics Netherlands).[36] Parental education level was recoded in three categories according to the Dutch standard classification as defined by Statistics Netherlands:[37] high level (academic higher education/university education, higher professional education), mid level (pre-university education, senior secondary education, and senior secondary vocational education), and low level (preparatory secondary vocational education, lower secondary vocational education, primary education, and no education).

Statistical analysis

Mean and frequency differences in sociodemographic characteristics between the subgroups of parent-reported screen time were examined using t-tests for continuous variables and Chi-square statistics for categorical variables. We examined differences in children's screen time by parenting styles using Chi-square statistics. We used multivariable logistic regres-

sion analyses to test the associations between parenting style, the home environment and children's screen time. We report the odds ratios (ORs) and 95% confidence intervals (CIs) for all models.

First, we tested the association between the parenting style dimensions, parenting style categories, and the child's screen time. Second, we tested the associations between the social and physical home environment characteristics and the child's screen time. Further, to test whether the association between parenting style and the child's screen time (basic model) was mediated by the home environment, we adjusted the basic model for each social and physical home environment characteristic one at a time.

Additionally, we also checked for potential effect-modification by the physical home environment characteristics or the sociodemographic characteristics in the associations between practices (i.e. the social environment) and the child's screen time. No significant interactions were found for the physical environment characteristics and no consistent interactions were found for the sociodemographic characteristics. We therefore decided not to stratify the analyses. We adjusted the analyses for the sociodemographic characteristics (sex and age of the child, child's ethnic background, educational level of the parent, parent employment status, and family structure).

Only children with complete data concerning screen time were included for analyses. Of all other variables included in the study, the percentages of missing values ranged from 0.1 – 11.9 with approximately two-thirds of the variables having <5% missing values. Because the missing values were not completely at random, we used the multiple imputation procedure in SPSS (version 20.0). The imputation procedure was carried out using all variables in the study except parent age and sex of the parent. All analyses were performed on both the original dataset with complete cases[38] and the five imputed datasets and were then compared. Because there were no differences in the direction of the associations found, the ORs and their CIs presented are the pooled results of the analyses performed on the imputed datasets.

We performed the analyses using SPSS 20 for Windows (International Business Machines (IBM) Corp., SPSS Statistics, version 20.0, Armonk, New York, USA).

RESULTS

Table 7.1 shows the general characteristics of the parents and children included in the study. Mean age of the children in the study population (total n = 3067) was 5.8 (SD 0.4) years and 49.3% were male. Children with a mother with a low educational level and children of non-

Table 7.1 Characteristics of the total study population (n = 3067) and by amount of time watching TV (TV ≤2 hrs/day versus >2 hrs/day) and by amount of time using (game) computers (≤30 min/day versus >30 min/day)

	Total	Watching TV			Using (game) computers		
		≤2 hrs/day (n = 2419)	>2 hrs/day (n = 648)	*p*-value[a]	≤30 min/day (n = 2601)	>30 min/day (n = 466)	*p*-value[a]
Parent characteristics							
Mean age, years (SD)	36.9 (4.6)	37.0 (4.4)	36.6 (5.1)	0.12	36.8 (4.5)	37.1 (5.0)	0.21
Mother is respondent, n (%)	2762 (90.5)	2185 (90.8)	577 (89.5)	0.31	2347 (90.7)	415 (89.6)	0.50
Low educational level[b], n (%)	579 (19.4)	370 (15.7)	209 (33.0)	<0.001	434 (17.2)	145 (32.0)	<0.001
Not employed, n (%)	929 (33.1)	732 (33.2)	197 (32.8)	0.98	778 (32.8)	151 (35.0)	0.45
Single parent, n (%)	183 (6.0)	120 (5.0)	63 (9.8)	<0.001	151 (5.8)	32 (6.9)	0.41
Child characteristics							
Mean age, years (SD)	5.8 (0.4)	5.8 (0.4)	5.8 (0.4)	0.11	5.8 (0.4)	5.9 (0.4)	<0.001
Boy, n (%)	1509 (49.3)	1187 (49.2)	322 (49.7)	0.82	1205 (46.4)	304 (65.2)	<0.001
Non-Dutch ethnic background, n (%)	321 (11.1)	210 (9.1)	111 (18.8)	<0.001	248 (10.1)	73 (16.7)	<0.001
Child screen time							
Watching TV, min/day (SD)	86.3 (53.2)	65.2 (31.8)	165.0 (42.2)	<0.001	80.1 (49.1)	120.9 (61.4)	<0.001
Using (game) computers, min/day (SD)	17.0 (23.2)	13.8 (17.2)	29.3 (35.4)	<0.001	9.5 (8.5)	59.3 (32.0)	<0.001

The means and frequencies presented are means and frequencies of the original dataset. Missing values were 16 (0.5%) for age of the parent, 15 (0.5%) for sex of the parent, 84 (2.7%) for educational level, 17 (0.6%) for family structure, 264 (11.9%) for employment status of the parent, 239 (7.8%) for age of the child, 4 (0.1%) for sex of the child, and 182 (5.9%) for ethnic background of the child.

[a] T-tests were used for continuous variables and Chi-square statistics were used for categorical variables to examine differences between the subgroups of children that watch TV ≤2 hrs/day versus watch TV >2 hrs/day and between the subgroups of children that use (game) computers ≤30 min/day versus >30 min/day on (game) computers; the *p*-values are the pooled results of analysis of the five imputed datasets.

[b] Low education = no education, primary education, lower secondary vocational education, and preparatory secondary vocational education; mid education = senior secondary vocational education, senior secondary education, and pre-university education; high education = higher professional education, academic higher education (university education).

Table 7.2 Logistic regression analyses for association between parenting style and children's screen time (n = 3067)

	Watching TV >2 hrs/day		Using (game) computers >30 min/day	
		OR (95% CI)		OR (95% CI)
Parenting style dimensions	**Mean (SD)**		**Mean (SD)**	
Involvement	4.4 (0.4)	0.88 (0.70 – 1.12)	4.4 (0.4)	1.34 (1.02 – 1.77)
Strictness	4.4 (0.6)	0.92 (0.79 – 1.07)	4.4 (0.6)	1.10 (0.92 – 1.31)
Parenting style categories	**n (%)***		**n (%)****	
Authoritative (n = 1061)	202 (19.0)	1.00 (ref)	166 (15.6)	1.00 (ref)
Authoritarian (n = 399)	74 (18.5)	1.05 (0.78 – 1.43)	43 (10.8)	0.70 (0.48 – 1.03)
Indulgent (n = 426)	106 (24.9)	1.22 (0.92 – 1.62)	80 (18.8)	1.09 (0.79- 1.51)
Neglectful (n = 929)	223 (24.0)	1.20 (0.96 – 1.49)	144 (15.5)	0.87 (0.68 – 1.12)

For details on the measures used, see Appendix 7.1.

The means and frequencies presented are means and frequencies of the original dataset. Missing values were 252 (8.2%) for parenting style. To examine differences in watching TV and using (game) computers across parenting styles, Chi-square statistics were used; the p-values are the pooled results of analysis of the five imputed datasets.

The ORs are adjusted for sociodemographic characteristics (sex and age of the child, ethnic background of the child, educational level of the parent, employment status and family structure).

* $p < 0.05$ for difference across parenting styles.

** $p < 0.01$ for difference across parenting styles.

Dutch ethnic background were more likely to watch TV >2 hrs/day and spend >30 min/day on (game) computers. Further, children in single-parent families were more likely to watch TV >2 hrs/day and boys were more likely to spend >30 min/day on (game) computers.

In Table 7.2, the associations between parenting style and parent-reported screen time of the children are presented. Children of parents with a higher score on the parenting style dimension involvement were more likely to spend >30 min/day on (game) computers (1.34 (95% CI: 1.02-1.77)). Overall, families with an authoritative or authoritarian parenting style had lower percentages of children's screen time compared to families with an indulgent or neglectful parenting style. However, no difference in OR was found between subgroups with an authoritative parenting style and subgroups with another parenting style.

In Table 7.3 and Table 7.4, the associations between the characteristics of the social and physical home environment and children's screen time are presented. For example, children in families with rules about when and how long children are allowed to watch TV (present in 69.1% of all families) had an OR of 0.60 (95% CI: 0.47-0.76) for watching TV >2 hrs/day compared to children without these family rules. Children in families with rules about when and how long children are allowed to use (game) computers (present in 61.8% of the families) had an OR of 1.91 (95% CI: 1.47-2.48) for spending >30 min/day on (game) computers. For children with higher autonomy concerning using (game) computers, the OR was 1.50 (95% CI: 1.36-1.66). Further, the number of TVs and (game) computers present in the household

Table 7.3 Logistic regression analyses for associations between home environment characteristics and watching TV by the child (n = 3067)

		Watching TV >2 hrs/day, OR (95% CI)
Social home environment (parenting practices)		
Nr. of family rules about watching TV[a], n (%)		
1 rule (when or how long the child is allowed to watch TV)	457 (15.1)	0.91 (0.67 – 1.22)
2 rules (when and how long the child is allowed to watch TV)	2084 (69.1)	0.60 (0.47 – 0.76)
Parental monitoring concerning watching TV, always/often[b], n (%)	2596 (86.0)	0.55 (0.43 – 0.69)
Parental urging to turn off TV, always/often[b], n (%)	1267 (42.1)	0.94 (0.77 – 1.13)
Child autonomy concerning watching TV[c], mean (SD)	2.2 (0.9)	1.55 (1.40 – 1.70)
Physical home environment		
Nr. of TVs in household[d], n (%)		
1 TV	913 (31.3)	1.00
2-3 TVs	1872 (61.2)	1.79 (1.44 – 2.23)
≥4 TVs	128 (4.2)	2.83 (1.85 – 4.32)
Child has TV in bedroom, yes[e], n (%)	266 (8.7)	2.62 (2.00 – 3.44)

For details on the measures used, see Appendix 7.1.

The frequencies (n (%)) and means presented are frequencies and means of the original dataset. Missing values were 49 (1.6%) for family rules about watching TV, 47 (1.5%) for parental monitoring, 55 (1.8%) for parental urging to turn off the TV, 73 (2.4%) for child autonomy concerning watching TV, 7 (0.2%) for number of TVs in the household, and 12 (0.4%) for whether the child has a TV in the bedroom.

The ORs are the pooled results of analysis of the five imputed datasets.

The ORs are adjusted for sociodemographic characteristics (sex and age of the child, ethnic background of the child, educational level of the parent, employment status and family structure).

[a]The reference category (OR = 1.00) is 'no rules'

[b]The reference category (OR = 1.00) is 'never, seldom, or sometimes'

[c]An increase on child autonomy indicates higher autonomy of the child concerning screen time.

[d]Households without a TV (n = 147, 4.8%) were excluded from analysis.

[e]The reference category (OR = 1.00) is 'no'

was positively associated with children's screen time, and children who have a TV or (game) computer in their bedroom had higher odds for watching TV >2 hrs/day and spending >30 min/day on (game) computers.

We found a statistically significant association between the parenting style dimension involvement and using (game) computers by the child (Table 7.2), and tested whether this association was mediated by the home environment. Adding the home environment characteristics to the model changed the OR in the range between 2.9% and 23.5% (Appendix 7.2). After adjustment for the relevant home environment characteristics (characteristics that changed the OR >10%), the association between the parenting style dimension involvement and use of (game) computers by the child was no longer statistically significant (OR 1.30 (95% CI: 0.98-1.72), data not shown).

Table 7.4 Logistic regression analyses for associations between home environment characteristics and using (game) computers by the child (n = 3067)

		Using (game) computers >30 min/day, OR (95% CI)
Social home environment (parenting practices)		
Nr. of family rules about using (game) computers[a], n (%)		
1 rule (when or how long the child is allowed to use a (game) computer)	232 (7.9)	1.80 (1.17 – 2.77)
2 rules (when and how long the child is allowed to use a (game) computer)	1823 (61.8)	1.91 (1.47 – 2.48)
Parental monitoring concerning using (game) computers, always/often[b], n (%)	2353 (80.5)	1.60 (1.20 – 2.12)
Parental urging to turn off (game) computer, always/often[b], n (%)	876 (30.0)	2.34 (1.89 – 2.90)
Child autonomy concerning using (game) computers[c], mean (SD)	2.0 (1.7)	1.50 (1.36 – 1.66)
Physical home environment		
Nr. of (game) computers in household[d], n (%)		
1 computer	1208 (39.6)	1.00
2-3 computers	1191 (39.1)	1.91 (1.51 – 2.42)
≥4 computers	259 (8.5)	3.64 (2.62 – 5.07)
Child has (game) computer in bedroom, yes[e], n (%)	468 (15.3)	2.57 (2.03 – 3.25)

For details on the measures used, see Appendix 7.1.

The frequencies (n (%)) and means presented are frequencies and means of the original dataset. Missing values were 116 (3.8%) for family rules about using (game) computers, 145 (4.7%) for parental monitoring, 146 (4.8%) for parental urging to turn off the (game) computer, 158 (5.2%) for child autonomy concerning using (game) computers, 19 (0.6%) for number of (game) computers in the household, and 10 (0.3%) for whether the child has a (game) computer in the bedroom.

The ORs are the pooled results of analysis of the five imputed datasets.

The ORs are adjusted for sociodemographic characteristics (sex and age of the child, ethnic background of the child, educational level of the parent, employment status and family structure).

[a]The reference category (OR = 1.00) is 'no rules'.

[b]The reference category (OR = 1.00) is 'never, seldom, or sometimes'.

[c]An increase on child autonomy indicates higher autonomy of the child concerning screen time.

[d]Households without a (game)computer (n = 390, 2.7%) were excluded from analysis.

[e]The reference category (OR = 1.00) is 'no'.

DISCUSSION

In this study among more than three thousand 5-year-old children from different parts of the Netherlands, we investigated associations between parenting style, the home environment, and parent-reported screen time. First, as hypothesized, children's screen time was lower for children in families with an authoritative or authoritarian parenting style compared to children in families with an indulgent or neglectful parenting style. However, we only found a statistically significant association between the parenting style dimension involvement and using (game) computers by the child (children with parents with higher involvement, were more likely to spend >30 min/day on (game) computers). No difference in OR was found be-

tween subgroups with an authoritative parenting style and subgroups with another parenting style. Second, as hypothesized, we found that children in families with rules and parental monitoring regarding watching TV are less likely to watch TV >2 hrs/day and that children with higher autonomy regarding watching TV are more likely to watch TV >2 hrs/day. Further, having multiple TVs within the household and a TV in the child's bedroom is associated with higher odds for watching TV >2 hrs/day. Overall, the results for spending >30 min/day on (game) computers were comparable to these results for watching TV >2 hrs/day. Thirdly, we found that characteristics of the social home environment mediated the association between the parenting style dimension involvement and children's use of (game) computers.

We found that children are more likely to spend >30 min/day on (game) computers in families where rules are present concerning using (game) computers, where parents urge the child to turn off the (game) computer, and where parents monitor the time a child uses (game) computers. The directions of these associations are unlike those for watching TV and were not as expected. However, as we used cross-sectional data, the direction of these associations might be the other way around. In other words, it might be that parents have rules about the amount of computer use and monitor the time their child uses (game) computers because the child was spending relatively large amounts of time on (game) computers. From our data, 1920 (62.6%) children in the study population spent less than 15 minutes a day on a (game) computer, and 617 of these children (equal to 20.1% of the total study population) did not spend any time on a (game) computer. We repeated the analyses after excluding the children who spent no time on a (game) computer. The higher odds for spending >30 min/day on (game) computers was no longer statistically significant for children with parental monitoring and with 1 family rule about using (game) computers.

Our new hypothesis that a child spending a relatively high amount of time on (game) computers leads to family rules about amount of computer use is strengthened by the finding that children with high autonomy regarding using (game) computers are also more likely to spend >30 min/day on (game) computers. However, over the past few years there has been an increase in the use of electronic media by very young children[39] and with the introduction of smart phones and tablets more parents are probably introducing rules on the amount of time a child may spend using a device.

In the main analyses, we chose to use the continuous parenting style dimensions strictness and involvement instead of a categorization in the four parenting styles, as this categorization is arbitrary, sample specific and causes reduction in measurement reliability.[35, 40, 41] We also investigated the effect of the two parenting style dimensions in combination, and the interactions appeared to be non-significant (p-values >0.1, data not shown). In our study, we only used the categorization into the four parenting styles for interpretation purposes.

To categorize parents, we dichotomized the strictness and the involvement scales based on the median values of both scales in our study population.[24] Other studies defined the four parenting categories also by 'trichotomizing' both scales using tertiles (which presumably leads to more distinct parenting style groups compared to using dichotomization, as parents who score in the middle tertile are excluded from the analyses), or by using cut-off points for the scales.[42] For comparison; by using trichotomisation in our study population, 16.3% of the parents were classified authoritative, 1.3% as authoritarian, 4.4% as indulgent, and 18.5% as neglectful. By using the cut-off points of Steinberg et al, 9.4% of the parents were classified authoritative, 15.6% as authoritarian, 5.9% as indulgent, and 69.1% as neglectful. We recommend future studies to investigate cluster analytic approaches when categorizing parents into parenting styles.[43]

Other methodological considerations of the present study need to be addressed also. As we used cross-sectional data, the direction of the associations can not be confirmed. Further, child behavior was based on data reported by the parent. Parents might have given socially desirable answers even though anonymity was assured. Parent-reports are also susceptible to recall bias. However, by asking parents about their child's screen time on week days and weekend days separately, we took into account potential variation in screen time between weekdays and weekend days. Parents were asked to report the time their child spent watching TV and using (game) computers during an average week in total; we did not differentiate between households in the questionnaire. We did, however, adjust the analyses for family structure (two-parent family, single-parent family or other). To minimize the respondent burden, only one questionnaire was obtained per child, and in most cases this questionnaire was completed by the child's mother (90.5%). It was not possible in the present study to compare, for example, parenting style of the mother and the father. Further, the prevalence of overweight and obesity was relatively high in our study population, because all parents in the control group were asked to complete the questionnaire whereas only the parents of children with overweight or obesity in the intervention group were asked to complete the questionnaire.[28] The results reported in this study were the same when we repeated the main analyses and included the control group only. Based on this, we conclude that the relatively high prevalence of overweight and obesity in our study population did not affect the results reported in this study.

Our results support the evidence emerging from the literature of modifiable factors in the home environment that are associated with the time children spend watching TV or using (game) computers. The strengths of our study are that we included a large study population of young children with a small age range, therefore our results are specific to the 5-year-old age group. Further, we included two indicators of screen time (watching TV and using (game) computers) and analyzed the data separately. It has been recommended that watching TV

and using (game) computers should be investigated separately and not be combined as one screen-time variable as these behaviors relate differently to energy intake and energy expenditure.[22] The opposite associations we found between family rules and watching TV and family rules and using (game) computers further supports the need to investigate these indicators of screen time separately.

To our knowledge, our study is the first to investigate associations between parenting style, the home environment, and children's screen time. Although children in families with an authoritative and authoritarian parenting style had the lowest overall amount of parent-reported screen time compared to children in families with an indulgent or neglectful parenting style, our results indicated that the magnitude of the association between parenting style and children's screen time is relatively modest. Additionally, we investigated whether parenting style within the household might be an effect-modifier in the association between the social and physical home environment and screen time of the children. Parenting style within the household also appeared not to be an effect-modifier in any of the associations between the social or physical home environment characteristics and screen time (p-values >0.10 for all interaction terms, data not shown). This indicates independent associations between the social and physical home environment and children's screen time. A study among older children (aged 10-11 years), however, reported that permissive parenting (comparable with an indulgent parenting style) was associated with a higher level of watching TV compared to authoritative parenting.[17] Further, studies on energy intake among 6 to 8 year-olds[27] and 12 to 17 year-olds[35] also reported more pronounced effects of parenting practices on children's energy intake among households with an authoritative parenting style. Therefore, more longitudinal studies are needed to investigate a potential long-term effect of parenting style on children's screen time.

In 2007-2008, 8.7% of the 5-year-olds in our study population had a TV in their bedroom and 15.3% had a (game) computer in their bedroom. It is likely that nowadays these percentages are higher. In the present study, a TV and (game) computer in the bedroom was associated with a higher odds ratio for watching TV more than 2 hours a day and spending more than 30 minutes per day on (game) computers. In a qualitative study investigating the thought-process of parents behind having a TV in the child's bedroom,[44] it was reported that parents think that it assists with bedtime routine (i.e. children are in their bedroom and can watch TV until it is time for them to go to sleep), that it allows family members to each watch what they want, and that it stops fighting amongst children. It might be useful for interventions to discuss these incorrect notions of parents. Further, the study also indicated that once a TV is present in a child's bedroom it is difficult to remove and, therefore, it might be better to prevent the placement of a TV in the child's bedroom in the first place.

Our study provides new insights into the associations between parenting style, the home environment and children's screen time. The social and physical home environment has unique effects on children's screen time that are independent of parenting style. Our results indicate a relative modest association between parenting style and screen time at the age of 5 years. To reduce the time a child spends watching TV or using a (game) computer, it might be important to make parents more aware of the influence they have on their child's behavior, especially when the child is young. However, parents might find it an increasing challenge to limit their children's screen time because the changes in society increasingly promote children's screen time;[45, 46] for example the availability of multiple TV channels around the clock with programs for children, the increase in computer games aimed at children, but also the increase in use of electronic media in children's education. For these reasons, parents might experience it as a challenge to create a home environment that limits screen time. Therefore, it might be important that interventions aiming to reduce children's screen time address the social and physical environmental context in which children's screen time occurs. Such interventions might be most effective if they start during early childhood and before family habits are established. These interventions should improve the ability of parents to create and maintain a healthy home environment by providing the parents with information, skills, support, and encouragement to make changes in parenting practices and in the physical home environment. Future studies are needed to evaluate whether interventions that focus on improving the social and physical home environment (e.g. by promoting the introduction of family rules or 'passive controls' regarding screen time – for example software programs that restrict access to the TV or (game) computer–, by preventing the placement of a TV or (game) computer in (young) children's bedrooms, but also by suggesting alternative activities such as drawing or playing outside) indeed result in a reduction of the children's screen time.

REFERENCES

1. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev*. 2001;2(3):159-171.
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
3. Reilly JJ. Physical activity, sedentary behaviour and energy balance in the preschool child: opportunities for early obesity prevention. *The Proceedings of the Nutrition Society*. 2008;67(3):317-325.
4. Saelens BE, Sallis JF, Nader PR, Broyles SL, Berry CC, Taras HL. Home environmental influences on children's television watching from early to middle childhood. *J Dev Behav Pediatr*. 2002;23(3):127-132.
5. Hesketh K, Wake M, Graham M, Waters E. Stability of television viewing and electronic game/computer use in a prospective cohort study of Australian children: relationship with body mass index. *Int J Behav Nutr Phys Act*. 2007;4:60.
6. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-192.
7. Golan M, Crow S. Targeting parents exclusively in the treatment of childhood obesity: long-term results. *Obesity research*. 2004;12(2):357-361.
8. Darling N, Steinberg L. Parenting style as context: An integrative model. *Psychological Bulletin*. 1993;113(3):487-496.
9. Davison KK, Francis LA, Birch LL. Links between parents' and girls' television viewing behaviors: a longitudinal examination. *The Journal of pediatrics*. 2005;147(4):436-442.
10. Salmon J, Timperio A, Telford A, Carver A, Crawford D. Association of family environment with children's television viewing and with low level of physical activity. *Obesity research*. 2005;13(11):1939-1951.
11. Hardy LL, Baur LA, Garnett SP, Crawford D, Campbell KJ, Shrewsbury VA, Cowell CT, Salmon J. Family and home correlates of television viewing in 12-13 year old adolescents: the Nepean Study. *Int J Behav Nutr Phys Act*. 2006;3:24.
12. Adachi-Mejia AM, Longacre MR, Gibson JJ, Beach ML, Titus-Ernstoff LT, Dalton MA. Children with a TV in their bedroom at higher risk for being overweight. *Int J Obes (Lond)*. 2007;31(4):644-651.
13. Barradas DT, Fulton JE, Blanck HM, Huhman M. Parental influences on youth television viewing. *The Journal of pediatrics*. 2007;151(4):369-373, 373 e361-364.
14. van Zutphen M, Bell AC, Kremer PJ, Swinburn BA. Association between the family environment and television viewing in Australian children. *Journal of paediatrics and child health*. 2007;43(6):458-463.
15. Jago R, Page A, Froberg K, Sardinha LB, Klasson-Heggebo L, Andersen LB. Screen-viewing and the home TV environment: the European Youth Heart Study. *Preventive medicine*. 2008;47(5):525-529.
16. Te Velde SJ, van der Horst K, Oenema A, Timperio A, Crawford D, Brug J. Parental and home influences on adolescents' TV viewing: a mediation analysis. *Int J Pediatr Obes*. 2011;6(2-2):e364-372.
17. Jago R, Davison KK, Thompson JL, Page AS, Brockman R, Fox KR. Parental sedentary restriction, maternal parenting style, and television viewing among 10- to 11-year-olds. *Pediatrics*. 2011;128(3):e572-578.
18. Tandon PS, Zhou C, Sallis JF, Cain KL, Frank LD, Saelens BE. Home environment relationships with children's physical activity, sedentary time, and screen time by socioeconomic status. *Int J Behav Nutr Phys Act*. 2012;9:88.

19. Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Pediatrics*. 2002;109(6):1028-1035.
20. Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG. Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2008;5:31.
21. Gubbels JS, Kremers SP, Stafleu A, de Vries SI, Goldbohm RA, Dagnelie PC, de Vries NK, van Buuren S, Thijs C. Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA Birth Cohort Study. *Int J Behav Nutr Phys Act*. 2011;8:18.
22. de Jong E, Visscher TL, Hirasing RA, Heymans MW, Seidell JC, Renders CM. Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. *Int J Obes (Lond)*. 2013;37(1):47-53.
23. Huver RM, Otten R, de Vries H, Engels RC. Personality and parenting style in parents of adolescents. *Journal of adolescence*. 2010;33(3):395-402.
24. De Bourdeaudhuij I, Te Velde SJ, Maes L, Perez-Rodrigo C, de Almeida MD, Brug J. General parenting styles are not strongly associated with fruit and vegetable intake and social-environmental correlates among 11-year-old children in four countries in Europe. *Public health nutrition*. 2009;12(2):259-266.
25. Barkin S, Ip E, Richardson I, Klinepeter S, Finch S, Krcmar M. Parental media mediation styles for children aged 2 to 11 years. *Archives of pediatrics & adolescent medicine*. 2006;160(4):395-401.
26. Loprinzi PD, Cardinal BJ, Loprinzi KL, Lee H. Parenting practices as mediators of child physical activity and weight status. *Obesity facts*. 2012;5(3):420-430.
27. Sleddens EFC. Thesis: "Childhood overweight. The influence of parenting on children's energy balance-related behavior. Chapter 12: Food parenting practices and child dietary patterns: Prospective relations and the moderating role of general parenting, child temperament, and child eating style." Maastricht: Maastricht University; 2013.
28. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, Hirasing RA, Raat H. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health*. 2009;9:177.
29. van der Horst K, Oenema A, van de Looij-Jansen P, Brug J. The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren. *BMC Public Health*. 2008;8:142.
30. Jaddoe VW, van Duijn CM, Franco OH, van der Heijden AJ, van Iizendoorn MH, de Jongste JC, van der Lugt A, Mackenbach JP, Moll HA, Raat H, Rivadeneira F, Steegers EA, Tiemeier H, Uitterlinden AG, Verhulst FC, Hofman A. The Generation R Study: design and cohort update 2012. *European journal of epidemiology*. 2012;27(9):739-756.
31. van de Laar CWE, Renders CM, Dijkman MAM, HiraSing RA. Aanpak overgewicht in de Jeugdgezondheidszorg. De ontwikkeling en evaluatie van een Minimal Interventie Strategie bij kinderen van groep 2 uit het basisonderwijs. [Tackling overweight in Youth Healthcare. The development and evaluation of a Minimal Intervention Strategy among children at the start of elementary school]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Centre; 2006.
32. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.

33. American Academy of Pediatrics. Committee on Public Education: Children, adolescents, and television. *Pediatrics*. 2001;107(2):423-426.
34. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet*. 2002;360(9331):473-482.
35. van der Horst K, Kremers S, Ferreira I, Singh A, Oenema A, Brug J. Perceived parenting style and practices and the consumption of sugar-sweetened beverages by adolescents. *Health education research*. 2007;22(2):295-304.
36. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. Den Haag/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
37. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Standaard Onderwijsindeling 2003 [The Dutch Standard Classification of Education]. Voorburg/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
38. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, Wood AM, Carpenter JR. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ (Clinical research ed*. 2009;338:b2393.
39. Vandewater EA, Rideout VJ, Wartella EA, Huang X, Lee JH, Shim MS. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics*. 2007;119(5):e1006-1015.
40. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. *Int J Pediatr Obes*. 2011;6(2-2):e12-27.
41. Taylor A, Wilson C, Slater A, Mohr P. Parent- and child-reported parenting. Associations with child weight-related outcomes. *Appetite*. 2011;57(3):700-706.
42. Steinberg L, Blatt-Eisengart I, Cauffman E. Patterns of Competence and Adjustment Among Adolescents from Authoritative, Authoritarian, Indulgent, and Neglectful Homes: A Replication in a Sample of Serious Juvenile Offenders. *J Res Adolesc*. 2006;16(1):47-58.
43. Power TG, Sleddens EF, Berge J, Connell L, Govig B, Hennessy E, Liggett L, Mallan K, Santa Maria D, Odoms-Young A, St George SM. Contemporary research on parenting: conceptual, methodological, and translational issues. *Childhood obesity (Print)*. 2013;9 Suppl:S87-94.
44. Crowder JS, Sisson SB, Ramey E, Arnold SH, Richardson S, DeGrace BW. How did the television get in the child's bedroom? Analysis of family interviews. *Preventive medicine*. 2012;55(6):623-628.
45. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive medicine*. 1999;29(6 Pt 1):563-570.
46. World Health Organization. Factsheet N^{0}311, Obesity and overweight: World Health Organization; March 2013. Available from http://www.who.int/mediacentre/factsheets/fs311/en/ (accessed July 5th 2013).

APPENDIX

Appendix 7.1 Items assessing parenting style and the social and physical home environment

Scale	Scale properties	Scale description	Translated items	Item response scale
Parenting style				
Dimension involvement	Cronbach's alpha 0.75 Scale range 1-5	General parenting style dimension involvement	– When someone within our family comes home or leaves home, than he or she let other family members know	1 =strongly agree to 5 = strongly disagree
			– I encourage my child to try harder when he or she receives a poor grade in school	1 = strongly agree to 5 = strongly disagree
			– I help my child with an assignment that he or she does not understand	1 = strongly agree to 5 = strongly disagree
			– My child can count on me when he or she has some kind of problem	1 = strongly agree to 5 = strongly disagree
			– I find it very easy to talk openly with my child	1 = strongly agree to 5 = strongly disagree
			– I spend time just talking with my child	1 = strongly agree to 5 = strongly disagree
			– When my child receives a good grade in school, I show him or her my approval	1 = strongly agree to 5 = strongly disagree
			– We do things for fun together regularly as a family	1 = strongly agree to 5 = strongly disagree
			– When my child gets a poor grade in school, I suggest to help	1 = strongly agree to 5 = strongly disagree
Dimension strictness	Cronbach's alpha 0.78 Scale range 1-5	General parenting style dimension strictness	– I really know what my child does in her or his free time	1 = strongly agree to 5 = strongly disagree
			– I try to know where my child is in the afternoon after school	1 = strongly agree to 5 = strongly disagree
			– I really know where my child goes at night	1 = strongly agree to 5 = strongly disagree
			– I really know where my child is in the afternoon after school	1 = strongly agree to 5 = strongly disagree
			– I try to know where my child goes at night	1 = strongly agree to 5 = strongly disagree
			– I try to know what my child does in her or his free time	1 = strongly agree to 5 = strongly disagree

Appendix 7.1 (Continued)

Scale	Scale properties	Scale description	Translated items	Item response scale
Social home environment (parenting practices)				
Family rules about watching TV	Index range 1-3	Number of rules about watching TV by the child reported by the parents	Do you have rules in your household about:	
			– When your child is allowed to watch TV?	no/yes
			– How long your child is allowed to watch TV?	no/yes
Family rules about using (game) computers	Index range 1-3	Number of rules about using (game) computers by the child reported by the parents	Do you have rules in your household about:	
			– When your child is allowed to use a (game) computer?	no/yes
			– How long your child is allowed to use a (game) computer?	no/yes
Parental monitoring watching TV	-	Parental monitoring concerning watching TV by the child	To what extent do you monitor for how long your child watches TV?	1 = never to 5 = always
Parental monitoring using (game) computers	-	Parental monitoring concerning using (game) computers by the child	To what extent do you monitor for how long your child uses (game) computers?	1 = never to 5 = always
Parental urging TV	-	Parents urge their child to turn off the TV	How often do you tell your child to turn off the TV?	1 = never to 5 = always
Parental urging (game) computer	-	Parents urge their child to turn off the (game) computer	How often do you tell your child to turn off the (game) computer?	1 = never to 5 = always
Child autonomy watching TV	Cronbach's alpha 0.90 Scale range 1-5		How often is your child allowed to decide for himself or herself:	
			– Whether he or she watches TV?	1 = never to 5 = always
			– When he or she watches TV?	1 = never to 5 = always
			– For how long he or she watches TV?	1 = never to 5 = always
Child autonomy using (game) computers	Cronbach's alpha 0.94 Scale range 1-5		How often is your child allowed to decide for himself or herself:	
			– Whether he or she uses a (game) computer?	1 = never to 5 = always
			– When he or she uses a (game) computer?	1 = never to 5 = always
			– For how long he or she uses a (game) computer?	1 = never to 5 = always

Appendix 7.1 (Continued)

Scale	Scale properties	Scale description	Translated items	Item response scale
Physical home environment				
Nr. of TVs in household	Scale range 1-5	Number of TVs that are present in the household	How many TVs do you have in your household?	1 = 0 TVs to 5 = 4 TVs or more
TV in child's bedroom	-	Availability of a TV in the child's bedroom	Does your child have a TV in his or her bedroom?	no/yes
Nr. of (game) computers in the household	Scale range 1-5	Number of (game) computers in the household	How many (game) computers do you have in your household?	1 = 0 (game) computers to 5 = 4 (game) computers or more
(Game) computer in child's bedroom	-	Availability of a (game) computer in the child's bedroom	Does your child have a (game) computer in his or her bedroom?	no/yes

Appendix 7.2 Logistic regression analyses for the association between the parenting style dimension involvement and using (game) computers >30 min/day by the child, and the association after adjustment for social and physical environment characteristics (n = 3067)

	Using (game) computers >30 min/day, OR (95% CI)	Change[a]
Parenting style dimension involvement (basic model)	1.34 (1.02 – 1.77)	
Basic model + social home environment (parenting practices)		
Nr. of family rules about using (game) computers	1.31 (1.00 – 1.74)	-8.8%
Parental monitoring concerning using (game) computers	1.29 (0.98 – 1.71)	-14.7%
Parental urging to turn off (game) computer	1.26 (0.95 – 1.66)	-23.5%
Child autonomy concerning using (game) computers	1.41 (1.07 – 1.86)	+20.6%
Basic model + physical home environment		
Nr. of (game) computers in household	1.33 (1.00 – 1.77)	-2.9%
Child has (game) computer in bedroom	1.32 (1.00 – 1.74)	-5.9%

For details on the measures used, see Appendix 7.1.

The ORs are the pooled results of analysis of the five imputed datasets.

The ORs are adjusted for sociodemographic characteristics (sex and age of the child, ethnic background of the child, educational level of the parent, employment status and family structure).

[a] Change represent the change in OR relative to the basic model after adjustment for the characteristics of the social and physical home environment ($[OR_{basic\ model+characteristic} - OR_{basic\ model}]/[OR_{basic\ model} - 1] \times 100$).

8

General discussion

INTRODUCTION

In the last decades, there has been a dramatic increase in the prevalence of childhood overweight and obesity worldwide. In the Netherlands, the prevalence of overweight and obesity has more than doubled since 1980. In 2009, 13.3% of the boys and 14.9% of the girls had overweight, and 1.8% and 2.2% had obesity. Childhood overweight and obesity are a major burden on health care. In 2004, an overweight detection protocol was developed for use in the youth healthcare setting to uniformly detect childhood overweight and obesity. According to this protocol, the age and sex specific cut-off points for the body mass index presented by the International Obesity Task Force (IOTF) are used to assess children's weight status. In 2005, the overweight prevention protocol was developed for use in the youth healthcare setting. In this intervention, the focus is on the following 5 elements; 1) stimulating breastfeeding, 2) stimulating to have breakfast regularly, 3) reducing the intake of sweet beverages, 4) stimulating physical activity (especially playing outside), and 5) reducing watching TV and using (game) computers.

The overall aim of this thesis was to provide new insights into overweight assessment and risk factors for overweight in young children, which might improve the prevention of childhood overweight and obesity. The aims of this thesis were:

1. To develop a study to implement and evaluate the overweight prevention protocol. (Chapter 2)
2. To investigate the agreement between the body mass index and measures of waist circumference in the identification of overweight among 5-year-old children. (Chapter 3)
3. To investigate the associations between socioeconomic status, ethnic background, and overweight among 5-year-old children. (Chapter 4 and 5)
4. To investigate the associations between lifestyle-related behaviors and overweight among 5-year-old children. (Chapter 6)
5. To investigate the associations between parenting style, the home environment, and screen time of 5-year-old children. (Chapter 7)

In this general discussion, first the study that was developed to evaluate the effects of the overweight prevention protocol, and the findings of this effectevaluation, are described briefly. Second, the main findings of the studies described in this thesis are discussed in a broader context. Third, methodological strengths and limitations are highlighted. Further, recommendations for future research and for the practice setting are given. The chapter ends with a final conclusion of this thesis.

DEVELOPMENT AND FINDINGS OF THE CLUSTER-RANDOMIZED CONTROLLED TRIAL OF THE 'BE ACTIVE, EAT RIGHT' STUDY

The first aim of this thesis was to develop a study to implement and evaluate the overweight prevention protocol. In **Chapter 2** of this thesis, the development and the design of the study are described, which aimed to assess the effects of the overweight prevention protocol on body mass index (BMI) and waist circumference (WC), and health-related behavior among children. A cluster-randomized controlled trial was conducted among 5-year-old children and their parents. Interventions for overweight prevention should start preferably early in life. Children were included at the age of 5 years, because at that age all children and parents in the Netherlands are invited for a regular well-child visit by youth healthcare professionals at municipal health services. Of the 37 municipal health services in the Netherlands, 9 services with 44 teams of youth healthcare professionals agreed to participate in the study. The 44 teams of youth healthcare professionals were randomly allocated to the intervention or control group. A total of 13,638 parents of 5-year-olds were invited by mail for the free-of charge well-child visit by one of the 9 municipal health services. Of the parents 64.4% (n=8784) provided written informed consent to participate in the 'Be active, eat right' study. The trained youth healthcare professionals measured weight, height and WC of all children during the well-child visits. When a child was detected as having overweight in the intervention group, the overweight prevention protocol was applied. According to this protocol parents of children with overweight were invited for up to three counseling sessions during which they received personal advice about a healthy lifestyle (with a focus on the four lifestyle-related behaviors having breakfast, drinking sweet beverages, physical activity (especially playing outside), and watching TV and using (game) computers), and the parents were motivated for and assisted in behavioral change. Parents completed questionnaires including items on the four lifestyle-related behaviors, parenting style, parenting practices, and home environment characteristics. Baseline data were collected during the 2007-2008 school year when the children were at the age of 5 years, and data was collected after 12 and 24 months of follow-up. The baseline data were used for the chapters 3 until chapter 7 of this thesis.

Meanwhile, the overweight prevention protocol has been evaluated and the effects of the intervention have been reported; limited effects on health behavior and BMI of the children were found.[1, 2] In the intervention group, a smaller increase in BMI for children with mild overweight (BMI 17.25 and 17.50) was observed. Children in both the intervention and control group appeared to consume less sweet beverages at follow-up compared to baseline.

Below, some possible explanations are described why limited effects of the overweight prevention protocol were observed. The teams of youth healthcare professionals were randomly

allocated to the intervention or control group. This procedure limited contamination of the control group; the youth healthcare professionals offered either the overweight prevention protocol to parents of children with overweight, or they offered parents usual care. However, both the prevention of childhood overweight and the introduction of the overweight prevention protocol received much attention over the years, and although the healthcare professionals in the control group were not trained to use the overweight prevention protocol, they were familiar with the protocol. This may have limited the contrast between the intervention and control group. Further, the healthcare professionals in the intervention group reported they had difficulties motivating parents to attend the additional counseling sessions and change overweight-related behavior. The healthcare professionals did receive training in motivational interviewing techniques, which can help to motivate and support parents to change behavior, but this training might have been insufficient. The attendance of the parents to the counseling sessions decreased during the intervention. This might also have diminished the potential effect of the intervention.[3]

In the Netherlands, youth healthcare monitors the growth and development of all children, which creates the opportunity to reach all children at risk for developing overweight and obesity. The overweight prevention protocol is a promising intervention that is widely adopted by and can be implemented in youth healthcare, but there are indications that the implementation can be improved. For example; providing youth healthcare professionals with more extensive training in motivational interviewing techniques, and use of tailored advice through the internet (complementing or replacing the additional face-to-face sessions), might increase participation of parents during the intervention.[3] Further, also the new insights provided in this thesis can be used to adjust the overweight prevention protocol. Future studies should investigate whether these adjustments will result in more effects of the overweight prevention protocol.

SUMMARY AND INTERPRETATION OF THE MAIN FINDINGS OF THIS THESIS

Assessment of overweight

The most common method of identifying overweight is the use of the BMI.[4-7] It has been indicated however that measuring only BMI might result in an underestimation of health risk.[8] The second aim of this thesis was to investigate the agreement between BMI and measures of WC in the identification of overweight among 5-year-old children. In **Chapter 3** of this thesis the comparison between BMI versus WC and BMI versus the waist-height ratio (WHtR) in the identification of overweight among 5-year-old children is described. Overall, the overweight markers BMI versus WC and BMI versus WHtR were only in moderate agreement on the presence of overweight among 5-year-olds. In the group of children classified as overweight

according to BMI, more than one-third was not classified as overweight according to WC or WHtR. Also in the group children classified as overweight according to WC, more than one-third was not classified overweight according to BMI. In the group of children classified as overweight according the WHtR, more than half of the total group was classified as overweight only according to the WHtR. The findings further indicated that BMI and WC merely agree among children with the highest amounts of overall body fat and abdominal fat. The results also showed that BMI might not be a sensitive marker among relatively tall or short children. The study described in chapter 3 was the first study to compare classification results between BMI and WC and between BMI and the WHtR, among 5-year-old children. A previous study that compared BMI and WC reported a strong correlation between BMI and WC.[9] The results described in chapter 3 suggest however, that BMI and WC merely agree on weight status among children with excess body fat in the highest percentile groups, including children with obesity. However, when prevention of further increase of excess body fat is considered, children with levels of BMI and WC near the norm are important. If only BMI cut-off points continue to be used by youth healthcare professionals as a basis for their assessment of overweight among 5-year-olds in monitoring programs, then part of the children classified as overweight according to WC might be missed. Future research should investigate whether this group of children is also at increased risk for overweight-related health problems.

Risk groups for overweight

The third aim of this thesis was to investigate the associations between socioeconomic status (SES), ethnic background, and overweight among 5-year-old children. **Chapter 4** of this thesis describes the association between maternal educational level, as an indicator of SES, and overweight and obesity, and **chapter 5** describes the differences in prevalence of overweight (including obesity) between subgroups of 5-year-old children of different ethnic background.

An inverse association was found between maternal educational level, as an indicator of SES, and overweight and obesity among the 5-year-old children. A review, which included 45 cross-sectional studies performed between 1989 and 2005, concluded that school-aged children whose parents (particularly mothers) have a lower level of education were at higher than average risk to have overweight.[10] Recent studies among 3-year-olds[11, 12] and 4-year-olds[13] found no association between SES and childhood overweight. These results suggest that differences in the prevalence of childhood overweight across SES levels appear at the age of 5 years. Other relatively recent studies among 5-year-olds confirm this.[14-18] The study described in chapter 4 further adds to the existing knowledge by demonstrating to what extent the inverse association between SES and early childhood overweight and obesity could be explained by lifestyle-related characteristics of the mother and child. The higher risk for overweight for the lower SES groups could be explained for more than 25% by watching TV by the mother and by the child, having breakfast by the child, and especially by maternal

weight status. The higher risk for obesity for the lower SES groups was explained for more than 40% by these factors.

It has been reported by previous studies in the Netherlands (which included study populations with other or wider age ranges) that children from Moroccan and Turkish ethnic background are at increased risk for having overweight and obesity.[19-21] In 2008-2009, the prevalence rates of overweight and obesity in Dutch children aged 2-21 years were 13.3% and 1.8% in boys, and 14.9% and 2.2% in girls.[22, 23] In comparison, these rates were 32.5% and 8.4% in Turkish boys, and 31.7% and 8.0% in Turkish girls. In Moroccan children, these rates were 25.2% and 6.0% in boys, and 29.1% and 7.5% in girls.[23] The study described in chapter 5 of this thesis also showed that, compared to Dutch children, children of Moroccan and Turkish ethnic background are at increased risk for having overweight at the age of 5 years. The study adds to the existing knowledge by examining to what extent this increased risk could be explained by parental overweight and lifestyle-related behaviors of the child. Adjustment for parental overweight decreased the odds for overweight for children with a Moroccan ethnic background with 10.2% and for children with a Turkish ethnic background with 12.5%. Taking into account lifestyle-related behaviors of the child (watching TV and having breakfast), further reduced the risk for having overweight among Moroccan and Turkish children (respectively with 7.9% and 12.2%), but these mediating factors did not fully explain the association. In the study described in chapter 5, no difference in risk for having overweight was found between children of Dutch Antillean ethnic background and Dutch children, and Surinamese children had lower risk for overweight. Further, the results of the study described in chapter 5 indicated that the effect of ethnic background may be independent of the effect of SES on the risk for overweight among children.

Behavioral risk factors for overweight

The fourth aim of this thesis was to investigate the associations between lifestyle-related behaviors and overweight among 5-year-old children. As described in **chapter 6**, children who did not have breakfast every day, and children who watched TV >2 hrs/day, were at increased risk for having overweight (obesity included). Further, when the number of risk behaviors (not having breakfast every day, drinking >2 glasses of sweet beverages/day, and spending <1 hr/day playing outside, and watching TV >2 hrs/day) in these young children increased, also the risk for having overweight and obesity increased.

There are numerous other studies that found associations between the four behaviors having breakfast, drinking sweet beverages, playing outside, watching TV, and childhood overweight,[24-34] but these studies included mainly older children (6 years or older). The study described in chapter 6 adds to the existing knowledge by including a large study population of 5-year-olds. Further, both dietary and physical activity factors were included at the same

time. In comparison with other studies, no associations were found between playing outside or drinking sweet beverages and the risk for having overweight. These associations are likely to appear when the children are getting older. Further, the study described in chapter 6 showed that a combination of several risk behaviors is a risk factor for having overweight; with an increasing number of risk behaviors, the risk for having overweight (obesity included) was also higher among the children.

Parenting style, home environment, and screen time

The global increase in childhood overweight and obesity has been ascribed partly to increases in children's screen time.[35-37] Parents have a large influence on their children's screen time,[35, 38] but studies investigating parenting and early childhood screen time are limited.[39-41] The fifth aim of this thesis was to investigate the associations between parenting style, the home environment, and screen time (watching TV and using (game) computers) of 5-year-old children, as described in **chapter 7.**

Children of parents with a higher score on the parenting style dimension involvement, appeared to be more likely to spend >30 min/day on (game) computers. Overall, families with an authoritative or authoritarian parenting style had lower percentages of children's screen time compared to families with an indulgent or neglectful style, but no significant difference in OR was found. Children in families with rules and parental monitoring (i.e. parenting practices; characteristics of the social home environment) regarding watching TV were less likely to watch TV >2 hrs/day and children with higher autonomy regarding watching TV were more likely to watch TV >2 hrs/day. Further, having multiple TVs within the household and a TV in the child's bedroom (i.e. characteristics of the physical home environment) was associated with higher odds for watching TV >2 hrs/day. Overall, the results for spending >30 min/day on (game) computers were comparable to these results for watching TV >2 hrs/day. The parenting practices appeared to mediate the association between the parenting style dimension involvement and children's use of (game) computers. Further, parenting style appeared not to be an effect-modifier in any of the associations between the social or physical home environment characteristics and children's screen time.

The results of the study described in chapter 7 support the evidence emerging from the literature for modifiable factors in the home environment that are associated with the time children spend watching TV or using (game) computers. The results of the study indicate that the magnitude of the association between parenting style and children's screen time is relatively modest at the age of 5 years. Further, the results showed that the associations of the social and physical home environment with children's screen time are independent of parenting style. Studies among older children (aged in the range between 6 and 17 year-old) however did find associations of parenting style on children's overweight-related behav-

ior.[42-44] This indicates that there might occur an effect of parenting style on children's screen time in the study population when the children are getting older.

METHODOLOGICAL CONSIDERATIONS

There are some methodological considerations that need to be taken into account when interpreting the results of the studies described in this thesis.

The studies described in chapters 3 to 7 are based on the baseline data of the 'Be active, eat right' study, which is described in chapter 2. For the 'Be active, eat right' study, 5-year-old children and their parents were included (participation rate 64.4%) during regular well-child visits performed by teams of youth healthcare professionals of municipal health services across the Netherlands. Of the 37 municipal health services in the Netherlands, an opportunity sample of 9 municipal health services was able and willing to participate in the study with 44 teams of youth healthcare professionals, covering both urban and rural areas. As an opportunity sample was included, this sample might not be representative of all municipal health services and youth healthcare teams in the Netherlands. Further, comparison of the prevalence of overweight and obesity among the Dutch children in the study populations described in this thesis (approximately 8.4% for overweight (including obesity) and 1.5% for obesity in 2007-2008) with prevalence rates presented for the total population of Dutch 5-year-olds in the Netherlands (approximately 15.5% for overweight (including obesity) and 2.7% for obesity in 2008-2009),[22] indicates that the prevalence rates in the studies presented in this thesis do not represent the situation in the Netherlands as a whole. Therefore, results of the studies should be generalized cautiously. In the context of this thesis, however, whether the *study populations* are representative is considered less important; more important is whether the *associations* that were found can be generalized to populations that were not in the source population.[45] It is assumed unlikely that the associations found in this thesis differ in the total population of 5-year-old children and their parents living in the Netherlands.

When comparing characteristics of children and parents in the populations for analysis with characteristics of those excluded from analyses due to missing data, there appeared to be some selection towards study populations with higher SES, more children of Dutch ethnic background, and populations with a healthier lifestyle. In chapter 7, a multiple imputation procedure was applied to handle the missing values, and results were compared with complete case analyses; no differences in the direction of the associations were found. This finding supports the validity of the results. However, the findings should be interpreted cautiously.

A relative large number of the children included in the 'Be active, eat right' study was of non-Dutch ethnic background (approximately 15%). The main non-Dutch, non-western subgroups present in the Netherlands (Moroccan, Turkish, Surinamese and Dutch Antillean)[46] were represented in the study populations. The definition of ethnic background of the child was based on country of birth, as suggested by Statistics Netherlands,[47] as this is the most objective and stable measure to use among young children in the context of the Netherlands.[48] The level of family acculturation in Dutch society may also be relevant for examining differences in weight status and lifestyle-related behavior across ethnic subgroups,[49] but this was not measured in the studies presented in this thesis. Further, by interpreting the results for the subgroup of children with a Surinamese ethnic background, it should be taken into account that a relatively small group was included in the study population, and that the composition of this subgroup might be mixed as Surinam is a multi-ethnic society.[20]

For all studies, relatively large populations for analyses could be included (in total 8784 parents participated in the 'Be active, eat right' study), which increases power to detect associations. In the analyses, the lifestyle-related behaviors were dichotomized based on international recommendations for interpretation purposes (risk behavior present or not), but this might have resulted in underestimation of associations by loss of information due to the dichotomization. Further, because of the small age range of the children, the results of the studies are specific for the 5-year-old age group. When interpreting the results, it should be taken into account that associations might change when children grow up. Further, the direction of the pathways underlying the associations that were studied cannot be confirmed, because cross-sectional data was used in all studies. In general, it is recommended to replicate the studies presented in this thesis longitudinally and among other varied populations of children and parents.

To assess characteristics of the parents and children, parent-reported data were used, which may have introduced bias, such as recall bias. Parents might also have given socially desirable answers, although anonymity was assured. Further, parents might not be aware of their child's behavior outside the home, for example at school or during after-school programs. The above may have lead to over- or underestimation of overweight-related behavior. For the study described in chapter 7, potential variation in behavior between weekdays and weekend days was taken into account by asking parents about their child's average screen time on week days and weekend days separately, as an approach to lower bias. To avoid bias, objective measures such as accelerometers and observations of overweight-related behavior could be used next to parent-reported data. Data on height, weight and WC of the children that were used in the studies described in this thesis were measured by trained youth health-care professionals, using standardized methods as described in a protocol.[50] These methods

are similar to those used in the Dutch nationwide growth studies.[22] The use of the protocol contributed to minimizing measurement error.

In the 'Be active, eat right' study, the international age and sex specific cut-off points for BMI presented by the IOTF were used to define overweight and obesity in the children. The IOTF cut-off points are also used in the Dutch youth healthcare setting as a diagnostic test for overweight and obesity.[50, 51] By using these cut-off points, national and international comparisons of the prevalence of childhood overweight and obesity, and comparisons of prevalence rates over time, are possible. The prevalence of overweight and obesity was higher in girls compared to boys in the studies presented in this thesis. This was found in other studies also, and might be the result of a lower sensitivity of the IOTF cut-off points in boys than girls.[4, 52, 53] It is recommended to investigate whether the identification of overweight and obesity in children in the youth healthcare setting can be improved by using alternative diagnostic tests.

RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the findings described in this thesis, future research is recommended for the following topics:

First, it is recommended to compare the subgroups of children identified as overweight according to BMI only, WC only, and WHtR only over time and to examine these children's weight development and risk of overweight-related health problems. It should be investigated whether it is cost-effective to also measure WC in addition to weight and height across the board in monitoring programs, or only among certain subgroups such as relatively tall or short children. In addition, future studies should investigate which cut-off points for WC or the WHtR are best to classify overweight among young children. Results of these studies may improve early identification and prevention of overweight and overweight-related health problems in children. There are already indications however that, compared to BMI and WC, WHtR is not a better indicator of body fat and cardiometabolic risk factors among 3-7 year-olds, and should therefore not be used in young children.[54] Further, it has been indicated that *changes* in BMI during childhood predict weight status and overweight-related cardiometabolic risk later in life,[55, 56] and future research should investigate how these changes in BMI could be used to identify children at risk for overweight-related health problems. Another non-invasive, relatively quick and inexpensive method for measuring body fat is bioelectrical impedance analysis (BIA). With BIA the fat-free mass and fat mass of a person are estimated based on the measured electrical impedance of the body. However, it requires equations specific to the instrument used and for the population under investigation, and the measure-

ment may vary with hydration status and ethnic background.[36] More research is needed to investigate which BIA method is most valid and reliable,[57] and whether this measurement might be applicable in the setting of youth healthcare.[58]

Second, research is needed to further explain differences in prevalence of early childhood overweight among subgroups of different SES and different ethnic background. Parental overweight and the behaviors having breakfast and watching TV appeared to be strong risk factors for childhood overweight, but could not explain the difference in risk completely. More studies and longitudinal studies are needed to examine the remaining explanatory factors, like characteristics of the environment (e.g. perceived safety of the neighborhood, availability of parks, playgrounds, and bike paths), prenatal, perinatal and postnatal factors (e.g. maternal smoking during pregnancy, birth weight, and receiving breastfeeding), parenting factors, social-cultural determinants, and these studies should include specific measures of diet and physical activity. These factors were not available for the studies described in this thesis. Further, more insight is needed into the attitude and potential perceived barriers regarding overweight-related behavior in the subgroups with increased risk for childhood overweight, for example by qualitative research. This information is needed to offer subgroups tailored advice and support in changing overweight-related behavior.

It is also recommended to use objective measures next to parent-reported data to assess certain characteristics of parents and children. To measure children's physical activity for example, accelerometers and observations of the child's behavior could be used next to parent-reported data. The data of the observations and accelerometers could also be used to evaluate the accurateness of parent-reported physical activity of the children.

Further, more longitudinal studies are recommended to study the causal relationships between the four lifestyle-related behaviors having breakfast, drinking sweet beverages, playing outside, watching TV, and early childhood overweight. It is also recommended to investigate the influence of the social and physical home environment, and parenting styles on children's screen time longitudinally.

RECOMMENDATIONS FOR THE PRACTICE SETTING

It has been hard to demonstrate success of interventions aimed at prevention of childhood overweight and obesity.[36, 59] Also the overweight prevention protocol appeared to have limited effect on children's BMI and health behavior.[1, 2] To date, there is still no clear evidence regarding the most health promoting and most cost-effective strategies, that can be widely implemented, and that have sustainable results with regard to prevention of childhood

overweight and obesity.[36, 59, 60] An important reason is that there is a multitude of factors that influence the development of overweight and obesity.[61] The new insights provided by this thesis into overweight assessment and risk factors for overweight in young children might lead to future research and adjustments of the overweight prevention protocol, that in turn might lead to more success in the prevention of childhood overweight and obesity.

A better understanding of the determinants of the health problem does however not necessarily helps in a better understanding of the solution of the health problem.[62] It is more relevant for policy and practice to know what should be changed in interventions to improve the prevention of childhood overweight and obesity. To increase the potential effects of the overweight prevention protocol, the implementation of the protocol can be improved. Increasing the motivational interviewing skills of youth healthcare professionals and the use of tailored advice (through the internet) might increase participation of parents in the intervention, and increase changes in overweight-related behavior within the families.[3] Below, further recommendations for the overweight prevention protocol are given, based on the new insights provided in this thesis.

In Dutch youth healthcare, the international age and sex specific cut-off points for BMI are used for identifying overweight and obesity among children. If necessary, the youth healthcare professionals also use their clinical judgment by taking into account the child's stature, ethnic background, and body-fat distribution in their decision on a child's weight status. The decision whether children and their parents are offered the overweight prevention protocol is therefore partly based on a non-standardized and relatively arbitrary clinical judgment of the youth healthcare professionals. Results of longitudinal studies examining the children classified as overweight according to BMI only, WC only, and WHtR only over time, will give indications whether WC should be measured in addition to BMI, or whether WC should be measured in certain subgroups (e.g. relatively tall or short children), to identify and monitor all children at increased risk for developing overweight-related health problems. Additionally, results of studies investigating the monitoring of BMI-changes during childhood and the use of BIA should be taken into account. The overweight detection protocol might be refined based on the results of this recommended research. This might also result in a less arbitrary decision by youth healthcare professionals on whether children and parents are offered the overweight prevention protocol.

Already at elementary school entry, children of low SES-subgroups and children with a Moroccan and Turkish ethnic background appear to be at increased risk for having overweight. It has been reported that disparities in childhood overweight by SES and ethnic background did not improve over time.[63] Others even indicated that disparities are increasing, which potentially contributes to increasing health inequalities.[11, 64, 65] It has also been indicated that

overweight prevention programs could worsen disparities because the better-off subgroups in society might be more likely to benefit from these programs.[59, 63] The overweight prevention protocol should take into account that already at the age of 5 years, children of lower SES-subgroups and Moroccan and Turkish children are at increased risk to have overweight. The factors parental weight status, having breakfast by the child, and watching TV in the household appear to contribute considerably to differences in risk. To reach, motivate and support specific subgroups in behavioral change to prevent overweight and obesity, special efforts and tailored advice and support might be needed, and social marketing techniques could be used.[61]

Further, the overweight prevention protocol should take into account that behavioral risk factors for overweight change when children grow up. There are many studies (which included mainly children aged 6 years and older) that found associations between having breakfast, drinking sweet beverages, playing outside, watching TV, and childhood overweight.[24-34] As described in this thesis, having breakfast and, especially, watching TV appear to be strong risk factors for having overweight at the age of 5, while no associations with drinking sweet beverages and playing outside were found at that age. The small average daily energy imbalance that is caused by spending too little time playing outside (as a marker for too little physical activity) and drinking too much sweet beverages per day probably have to sustain for several years before an effect on weight can be detected. Of the 5-year-old children in the study population described in this thesis, more than 64% appeared to drink more than 2 glasses of sweet beverages per day. It is likely that behavior that is present during early childhood persist during school age and even adolescence.[66, 67] Therefore, it is recommended to target all four behaviors already during early childhood for counseling and monitoring during well-child visits, before adverse habits are established. Besides, promotion of healthful diets and physical activity will benefit the health of all children, whether they are at risk for developing obesity or not.[36]

The current overweight prevention protocol could, next to overweight-related behaviors, focus more on the social and physical environmental context in which these behaviors occur.[59, 61] A supportive environment on the level of the home, as well as on the community and neighborhood level, is fundamental in shaping healthy behavior.[7] Children should have access to a healthy lifestyle. In this thesis, modifiable factors in the home setting are presented which could be targeted to reduce children's screen time. It might be important that youth healthcare professionals make parents more aware of the influence they have on their child's behavior, especially when the child is young. It may be effective to address the social and physical home environment during early childhood and before family habits are established. The youth healthcare professionals should improve the ability of parents to create and maintain a healthy home environment by providing the parents with information, skills, sup-

port, and encouragement to make changes in parenting practices and in the physical home environment. Youth healthcare professionals could for example promote the introduction of family rules regarding screen time, they could focus on preventing parents to place a TV or (game) computer in (young) children's bedrooms, and they could focus with parents on factors in the home environment that increase children's physical activity.

In general, focusing more on the whole-family health-centered approach in the overweight prevention protocol, rather than a weight-centered approach,[68] and emphasizing the influence of the home environment might be most effective in the setting of youth healthcare to increase a healthy lifestyle and prevent overweight and obesity in children.

In 2012, a guideline on overweight among children for youth healthcare was published, which incorporates the overweight prevention protocol.[58] Future studies should evaluate whether adaptations of the overweight prevention protocol will result in improvements of overweight-related behavior of children and in a reduction in the prevalence of overweight and obesity. However, an important note is that the increases in prevalence of overweight and obesity are largely attributed to social and environmental forces that overall improved our living conditions, but influenced our dietary and physical activity behavior (e.g. the intake of energy-dense foods increased, and also sedentary behavior increased). These forces are not under individual control, and certainly not under the control of children.[49, 59] Therefore, it is likely that a combined long term effort of parents and youth healthcare professionals alone is not sufficient; an integrated approach and changes in society as a whole are needed, to pursue sustainable effects of interventions to prevent childhood overweight and obesity.[36, 61, 69, 70]

CONCLUSION

In Dutch youth healthcare, BMI is used for the identification of overweight and obesity in children. There appears to be moderate agreement between BMI and measures of WC on the presence of overweight among 5-year-old children. BMI might not be a sensitive marker for overweight among relatively tall or short children. Future research should investigate whether measuring WC in addition to BMI improves early identification of children at increased risk for developing overweight-related health problems, and whether this approach is cost-effective.

Already at the start of elementary school, children of lower SES subgroups and of Moroccan and Turkish ethnic background are at increased risk for overweight and obesity. More insight is needed into the attitude and potential perceived barriers regarding healthy dietary and physical activity behavior of these subgroups, for example by using qualitative research.

Special attention should be given to parental weight status, having breakfast and watching TV in the household for these subgroups. To reach, motivate and support specific subgroups in behavioral change to prevent overweight and obesity, special efforts and adjustments of the protocol might be needed, and social marketing techniques could be used.

Children who do not have breakfast every day and children who watch TV for more than 2 hours per day are at increased risk for overweight (obesity included). Further, the more risk behaviors (not having breakfast every day, drinking more than 2 glasses of sweet beverages per day, playing outside less than 1 hour per day, and watching TV for more than 2 hours per day) are present, the higher the risk for having overweight and obesity. It is recommended to focus on and monitor lifestyle-related behavior during well-child visits, before adverse habits are established.

At the age of 5 years, there appear to be relatively modest associations between parenting style and children's screen time. The social and physical home environment has unique effects on children's screen time, independent of parenting style. To reduce children's screen time, it might be most effective when the overweight prevention protocol provides more specific guidelines for youth healthcare professionals to help parents with changing their child's behavior, for example by supporting parents to introduce and monitor family rules related to screen time, and by preventing parents to place a TV or (game) computer in the child's bedroom.

The new insights into overweight assessment and risk factors for overweight in young children described above might contribute to the improvement of prevention of childhood overweight and obesity.

REFERENCES

1. van Grieken A, Veldhuis L, Renders CM, Borsboom GJ, van der Wouden JC, Hirasing RA, Raat H. Population-based childhood overweight prevention: outcomes of the 'Be active, eat right' study. *PloS one*. 2013;8(5):e65376.
2. van Grieken A. Thesis: "Promotion of a healthy weight and lifestyle among children: The 'Be active, eat right' study. Chapter 3: Promotion of a healthy lifestyle among 5-year-old overweight children: health behavior outcomes of the 'Be active, eat right' study." Rotterdam: Erasmus University Rotterdam; 2013.
3. van Grieken A. Thesis: "Promotion of a healthy weight and lifestyle among children: The 'Be active, eat right' study. Rotterdam: Erasmus University Rotterdam; 2013.
4. Reilly JJ. Diagnostic accuracy of the BMI for age in paediatrics. *Int J Obes (Lond)*. 2006;30(4):595-597.
5. Krebs NF, Himes JH, Jacobson D, Nicklas TA, Guilday P, Styne D. Assessment of child and adolescent overweight and obesity. *Pediatrics*. 2007;120 Suppl 4:S193-228.
6. Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics*. 2009;124 Suppl 1:S3-22.
7. World Health Organization. Factsheet N⁰311, Obesity and overweight: World Health Organization; March 2013. Available from http://www.who.int/mediacentre/factsheets/fs311/en/ (accessed July 5th 2013).
8. McCarthy HD, Ellis SM, Cole TJ. Central overweight and obesity in British youth aged 11-16 years: cross sectional surveys of waist circumference. *BMJ (Clinical research ed*. 2003;326(7390):624.
9. Fredriks AM, van Buuren S, Fekkes M, Verloove-Vanhorick SP, Wit JM. Are age references for waist circumference, hip circumference and waist-hip ratio in Dutch children useful in clinical practice? *European journal of pediatrics*. 2005;164(4):216-222.
10. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity (Silver Spring, Md*. 2008;16(2):275-284.
11. Brunt H, Lester N, Davies G, Williams R. Childhood overweight and obesity: is the gap closing the wrong way? *J Public Health (Oxf)*. 2008;30(2):145-152.
12. van Rossem L, Silva LM, Hokken-Koelega A, Arends LR, Moll HA, Jaddoe VW, Hofman A, Mackenbach JP, Raat H. Socioeconomic status is not inversely associated with overweight in preschool children. *The Journal of pediatrics*. 2010;157(6):929-935 e921.
13. Semmler C, Ashcroft J, van Jaarsveld CH, Carnell S, Wardle J. Development of overweight in children in relation to parental weight and socioeconomic status. *Obesity (Silver Spring, Md*. 2009;17(4):814-820.
14. Albertini A, Tripodi A, Fabbri A, Mattioli M, Cavrini G, Cecchetti R, Dalle Donne E, Cortesi C, De Giorgi S, Contarini V, Andreotti L, Veronesi B, Stefanelli I, Di Martino E. Prevalence of obesity in 6- and 9-year-old children living in Central-North Italy. Analysis of determinants and indicators of risk of overweight. *Obes Rev*. 2008;9(1):4-10.
15. Dubois L, Girard M. Early determinants of overweight at 4.5 years in a population-based longitudinal study. *Int J Obes (Lond)*. 2006;30(4):610-617.
16. Wake M, Hardy P, Canterford L, Sawyer M, Carlin JB. Overweight, obesity and girth of Australian preschoolers: prevalence and socio-economic correlates. *Int J Obes (Lond)*. 2007;31(7):1044-1051.
17. Huus K, Ludvigsson JF, Enskar K, Ludvigsson J. Risk factors in childhood obesity-findings from the All Babies In Southeast Sweden (ABIS) cohort. *Acta Paediatr*. 2007;96(9):1321-1325.

18. Brophy S, Cooksey R, Gravenor MB, Mistry R, Thomas N, Lyons RA, Williams R. Risk factors for childhood obesity at age 5: analysis of the millennium cohort study. *BMC Public Health*. 2009;9:467.
19. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr*. 2005;94(4):496-498.
20. de Wilde JA, van Dommelen P, Middelkoop BJ, Verkerk PH. Trends in overweight and obesity prevalence in Dutch, Turkish, Moroccan and Surinamese South Asian children in the Netherlands. *Archives of disease in childhood*. 2009;94(10):795-800.
21. de Hoog ML, van Eijsden M, Stronks K, Gemke RJ, Vrijkotte TG. Overweight at age two years in a multi-ethnic cohort (ABCD study): the role of prenatal factors, birth outcomes and postnatal factors. *BMC Public Health*. 2011;11:611.
22. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA, van Buuren S. Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PloS one*. 2011;6(11):e27608.
23. Schönbeck Y, van Buuren S. Factsheet: Resultaten Vijfde Landelijke Groeistudie: TNO; 10th June 2010. Available from http://www.loketgezondleven.nl/object_binary/o10190_20100608-Factsheet-Resultaten-Vijfde-Landelijke-Groeistudie.pdf.
24. Burdette HL, Whitaker RC. A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics*. 2005;116(3):657-662.
25. Salmon J, Campbell KJ, Crawford DA. Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. *Med J Aust*. 2006;184(2):64-67.
26. Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by-environment interaction. *Pediatrics*. 2006;118(5):2066-2075.
27. Dubois L, Girard M, Potvin Kent M. Breakfast eating and overweight in a pre-school population: is there a link? *Public health nutrition*. 2006;9(4):436-442.
28. Lumeng JC, Rahnama S, Appugliese D, Kaciroti N, Bradley RH. Television exposure and overweight risk in preschoolers. *Archives of pediatrics & adolescent medicine*. 2006;160(4):417-422.
29. Blair NJ, Thompson JM, Black PN, Becroft DM, Clark PM, Han DY, Robinson E, Waldie KE, Wild CJ, Mitchell EA. Risk factors for obesity in 7-year-old European children: the Auckland Birthweight Collaborative Study. *Archives of disease in childhood*. 2007;92(10):866-871.
30. Dubois L, Farmer A, Girard M, Peterson K. Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool-aged children. *J Am Diet Assoc*. 2007;107(6):924-934; discussion 934-925.
31. Spinks AB, Macpherson AK, Bain C, McClure RJ. Compliance with the Australian national physical activity guidelines for children: relationship to overweight status. *Journal of science and medicine in sport / Sports Medicine Australia*. 2007;10(3):156-163.
32. Utter J, Scragg R, Schaaf D, Fitzgerald E, Wilson N. Correlates of body mass index among a nationally representative sample of New Zealand children. *Int J Pediatr Obes*. 2007;2(2):104-113.
33. Cleland V, Crawford D, Baur LA, Hume C, Timperio A, Salmon J. A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *Int J Obes (Lond)*. 2008;32(11):1685-1693.
34. Lim S, Zoellner JM, Lee JM, Burt BA, Sandretto AM, Sohn W, Ismail AI, Lepkowski JM. Obesity and sugar-sweetened beverages in African-American preschool children: a longitudinal study. *Obesity (Silver Spring, Md*. 2009;17(6):1262-1268.

35. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev*. 2001;2(3):159-171.
36. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5 Suppl 1:4-104.
37. Reilly JJ. Physical activity, sedentary behaviour and energy balance in the preschool child: opportunities for early obesity prevention. *The Proceedings of the Nutrition Society*. 2008;67(3):317-325.
38. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-192.
39. Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Pediatrics*. 2002;109(6):1028-1035.
40. Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG. Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2008;5:31.
41. Gubbels JS, Kremers SP, Stafleu A, de Vries SI, Goldbohm RA, Dagnelie PC, de Vries NK, van Buuren S, Thijs C. Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA Birth Cohort Study. *Int J Behav Nutr Phys Act*. 2011;8:18.
42. Jago R, Davison KK, Thompson JL, Page AS, Brockman R, Fox KR. Parental sedentary restriction, maternal parenting style, and television viewing among 10- to 11-year-olds. *Pediatrics*. 2011;128(3):e572-578.
43. Sleddens EFC. Thesis: "Childhood overweight. The influence of parenting on children's energy balance-related behavior. Chapter 12: Food parenting practices and child dietary patterns: Prospective relations and the moderating role of general parenting, child temperament, and child eating style." Maastricht: Maastricht University; 2013.
44. van der Horst K, Kremers S, Ferreira I, Singh A, Oenema A, Brug J. Perceived parenting style and practices and the consumption of sugar-sweetened beverages by adolescents. *Health education research*. 2007;22(2):295-304.
45. Bouter LM, van Dongen MCJM. *Epidemiologisch onderzoek; opzet en interpretatie [Epidemiological research; design and interpretation]*. vierde, herziene druk ed. Houten: Bohn Stafleu Van Loghum BV; 2000.
46. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Jaarrapport Integratie 2008 [Annual Report Integration 2008]. Den Haag/Heerlen: Centraal Bureau voor de Statistiek [Statistics Netherlands]; 2008.
47. Centraal Bureau voor de Statistiek [Statistics Netherlands]. Allochtonen in Nederland 2004 [Migrants in the Netherlands 2004]. In. Den Haag/Heerlen, The Netherlands: Centraal Bureau voor de Statistiek; 2004.
48. Stronks K, Kulu-Glasgow I, Agyemang C. The utility of 'country of birth' for the classification of ethnic groups in health research: the Dutch experience. *Ethnicity & health*. 2009;14(3):255-269.
49. Sussner KM, Lindsay AC, Peterson KE. The influence of maternal acculturation on child body mass index at age 24 months. *J Am Diet Assoc*. 2009;109(2):218-225.
50. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Signaleringsprotocol Overgewicht in de Jeugdgezondheidszorg [Youth Health Care Overweight-detection-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; November 2004.

51. Bulk-Bunschoten AMW, Renders CM, Van Leerdam FJM, HiraSing RA. Overbruggingsplan voor kinderen met overgewicht [Youth Health Care Overweight-prevention-protocol]. Amsterdam: Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center; September 2005.
52. Cattaneo A, Monasta L, Stamatakis E, Lioret S, Castetbon K, Frenken F, Manios Y, Moschonis G, Savva S, Zaborskis A, Rito AI, Nanu M, Vignerova J, Caroli M, Ludvigsson J, Koch FS, Serra-Majem L, Szponar L, van Lenthe F, Brug J. Overweight and obesity in infants and pre-school children in the European Union: a review of existing data. *Obes Rev*. 2009;11(5):389-398. Epub 2009 Jul 2010.
53. Reilly JJ, Kelly J, Wilson DC. Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. *Obes Rev*. 2010.
54. Sijtsma A, Bocca G, L'Abee C, Liem ET, Sauer PJ, Corpeleijn E. Waist-to-height ratio, waist circumference and BMI as indicators of percentage fat mass and cardiometabolic risk factors in children aged 3-7 years. *Clinical nutrition (Edinburgh, Scotland)*. 2013.
55. De Kroon ML, Renders CM, Van Wouwe JP, Van Buuren S, Hirasing RA. The Terneuzen birth cohort: BMI changes between 2 and 6 years correlate strongest with adult overweight. *PloS one*. 2010;5(2):e9155.
56. de Kroon ML, Renders CM, van Wouwe JP, van Buuren S, Hirasing RA. The Terneuzen Birth Cohort: BMI change between 2 and 6 years is most predictive of adult cardiometabolic risk. *PloS one*. 2010;5(11):e13966.
57. Talma H, Chinapaw MJ, Bakker B, Hirasing RA, Terwee CB, Altenburg TM. Bioelectrical impedance analysis to estimate body composition in children and adolescents: a systematic review and evidence appraisal of validity, responsiveness, reliability and measurement error. *Obes Rev*. 2013.
58. Kist-van Holthe JE, Beltman M, Bulk-Bunschoten AMW, L'Hoir M, Kuijpers T, Pijpers F, Renders CM, Timmermans-Leenders EP, Blok D-IJ, Van de Veer M, Hirasing RA. JGZ-richtlijn Overgewicht; Preventie, signalering, interventie en verwijzing van kinderen van 0-19 jaar [Overweight Guideline for Youth Healthcare; Prevention, detection, intervention and referral of children aged 0-19 years]. Utrecht: Nederlands Centrum Jeugdgezondheid; Mei 2012 [May 2012].
59. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane database of systematic reviews (Online)*. 2005(3):CD001871.
60. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, Armstrong R, Prosser L, Summerbell CD. Interventions for preventing obesity in children. *Cochrane database of systematic reviews (Online)*. 2011(12):CD001871.
61. Van Koperen TM, Jebb SA, Summerbell CD, Visscher TL, Romon M, Borys JM, Seidell JC. Characterizing the EPODE logic model: unravelling the past and informing the future. *Obes Rev*. 2013;14(2):162-170.
62. Robinson TN, Sirard JR. Preventing childhood obesity: a solution-oriented research paradigm. *American journal of preventive medicine*. 2005;28(2 Suppl 2):194-201.
63. Rossen LM, Schoendorf KC. Measuring health disparities: trends in racial-ethnic and socioeconomic disparities in obesity among 2- to 18-year old youth in the United States, 2001-2010. *Annals of epidemiology*. 2012;22(10):698-704.
64. Pinot de Moira A, Power C, Li L. Changing influences on childhood obesity: a study of 2 generations of the 1958 British birth cohort. *Am J Epidemiol*. 2010;171(12):1289-1298.
65. Knai C, Lobstein T, Darmon N, Rutter H, McKee M. Socioeconomic patterning of childhood overweight status in Europe. *International journal of environmental research and public health*. 2012;9(4):1472-1489.

66. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord*. 1999;23 Suppl 8:S1-107.
67. Hawkins SS, Law C. A review of risk factors for overweight in preschool children: a policy perspective. *Int J Pediatr Obes*. 2006;1(4):195-209.
68. Golan M, Crow S. Targeting parents exclusively in the treatment of childhood obesity: long-term results. *Obesity research*. 2004;12(2):357-361.
69. Whitaker RC. The childhood obesity epidemic: lessons for preventing socially determined health conditions. *Archives of pediatrics & adolescent medicine*. 2011;165(11):973-975.
70. Swinburn BA, de Silva-Sanigorski AM. Where to from here for preventing childhood obesity: an international perspective. *Obesity (Silver Spring, Md*. 2010;18 Suppl 1:S4-7.

Summary

Samenvatting

SUMMARY

Childhood overweight and obesity are a burden for children, parents and health care worldwide, and the prevention of childhood overweight and obesity is an international public health priority. In the Netherlands, the prevalence rates of overweight and obesity among children more than doubled since 1980, and in 2009 approximately 14% had overweight and 2.0% obesity. In 2004, the overweight detection protocol for children was developed for use in the Dutch youth healthcare setting. According to this protocol, the age and sex specific cut-off points for the body mass index (BMI) presented by the international obesity task force (IOTF) are used to assess children's weight status. Subsequently, the theory and practice-based childhood overweight prevention protocol was developed in 2005. In this intervention, the focus is on the following 5 elements; 1) stimulating breastfeeding, 2) stimulating to have breakfast regularly, 3) reducing the intake of sweet beverages, 4) stimulating physical activity (especially playing outside), and 5) reducing watching TV and using (game) computers. To obtain evidence about the effectiveness of the overweight prevention protocol, a study was needed to implement the protocol in the youth healthcare setting and to assess its effects. After development and implementation of an intervention, the intervention should be evaluated continuously and should be adjusted, refined, and improved to increase its quality.

The overall aim of this thesis is to provide new insights into overweight assessment and risk factors for overweight in young children.

The first aim of this thesis is to develop a study to implement and evaluate the overweight prevention protocol. **Chapter 2** of this thesis describes the development and the design of the 'Be active, eat right' study. In this study, the overweight prevention protocol was implemented and the study aimed to assess the effects of the protocol on BMI and waist circumference (WC) and health-related behavior among children. A cluster randomized controlled trial was conducted among 5-year-old children and their parents. Interventions for overweight prevention should start preferably early in life. Children were included at the age of 5 years, because at that age all children and parents in the Netherlands are invited for a regular well-child visit by youth healthcare professionals of municipal health services. Of the 37 municipal health services in the Netherlands, 9 municipal health services agreed to participate in the study with 44 teams of youth healthcare professionals. The 44 teams of youth healthcare professionals were randomly allocated to the intervention or control group. A total of 13,638 parents of 5-year-olds were invited by mail for the free-of charge well-child visit by one of the 9 municipal health services and 64.4% (n=8784) of the parents provided written informed consent to participate in the 'Be active, eat right' study. The trained youth healthcare professionals measured weight, height and waist circumference (WC) of all children during the well-child visits. When a child was detected as having overweight in the intervention

group, the overweight prevention protocol was applied. According to this protocol parents of children with overweight were invited for up to three counseling sessions during which they received personal advice about a healthy lifestyle, and the parents were motivated for and assisted in behavioral change. Parents completed questionnaires including items on the four lifestyle-related behaviors investigated in the 'Be active, eat right' study (having breakfast, drinking sweet beverages, playing outside (as an indicator of physical activity), and watching TV and using (game) computers), parenting style, parenting practices, and home environment characteristics. Baseline data were collected during the 2007-2008 school year when the children were at the age of 5 years, and data was collected after 12 and 24 months of follow-up. The baseline data were used for the chapters 3 until chapter 7 of this thesis. Meanwhile, the overweight prevention protocol has been evaluated and the effects of the intervention have been reported; limited effects on health behavior and BMI of the children were found. The new insights provided in this thesis can be used to adjust the overweight prevention protocol. Future studies should investigate whether these adjustments will result in more effects of the overweight prevention protocol.

The second aim of this thesis is to investigate the agreement between BMI and measures of WC in the identification of overweight among 5-year-old children. **Chapter 3** of this thesis describes the comparison between BMI versus WC and BMI versus the waist-height-ratio (WHtR) in the identification of overweight among 5-year-old children. Overall, the overweight markers BMI versus WC and BMI versus WHtR were only in moderate agreement on the presence of overweight among 5-year-olds. In the group of children classified as overweight according to BMI, more than one-third was not classified as overweight according to WC or WHtR. Also in the group children classified as overweight according to WC, more than one-third was not classified overweight according to BMI. In the group of children classified as overweight according the WHtR, more than half of the total group was classified as overweight only according to the WHtR. The findings further indicated that BMI and WC merely agree among children with the highest amounts of overall body fat and abdominal fat. Further, the results showed that BMI might not be a sensitive marker among relatively tall or short children.

The third aim of this thesis is to investigate the associations between socioeconomic status (SES), ethnic background, and overweight and obesity among 5-year-old children. **Chapter 4** of this thesis describes the association between maternal educational level, as an indicator of SES, and overweight and obesity. Inverse associations were found between maternal educational level and overweight, and between maternal educational level and obesity. These associations could be explained for more than 25% and more than 40% respectively by watching TV by the mother and by the child, having breakfast by the child, and especially maternal weight status. **Chapter 5** describes the differences in prevalence of overweight (including obesity) between subgroups of 5-year-old children of different ethnic background.

Compared to Dutch children, children of Moroccan and Turkish ethnic background were at increased risk for having overweight and obesity at the age of 5 years. Adjustment for parental overweight decreased the odds for Moroccan children with 10.2% and for Turkish children with 12.5%. Taking into account watching TV and having breakfast by the child, further reduced the odds for having overweight (including obesity) respectively with 7.9% and 12.2%. The risk for having overweight and obesity among children of Dutch Antillean ethnic background did not differ from Dutch children. Surinamese children had a lower risk for having overweight. Further, the results of the study indicated that the effect of ethnic background may be independent of the effect of SES on the risk for overweight and obesity among children.

The fourth aim of this thesis is to investigate the associations between lifestyle-related behaviors and overweight among 5-year-old children, and this is described in **chapter 6**. Children who did not have breakfast every day, and children who watched TV >2 hrs/day, were at increased risk for having overweight (obesity included). Further, when the number of risk behaviors (not having breakfast every day, drinking >2 glasses of sweet beverages/day, playing outside <1 hr/day, and watching TV >2 hrs/day) in these young children increased, also the risk for having overweight and obesity increased.

Finally, the fifth aim of this thesis is to investigate the associations between parenting style, the home environment, and screen time of 5-year-old children. This is described in **chapter 7** of this thesis. Children of parents with a higher score on the parenting style dimension involvement, appeared to be more likely to spend >30 min/day on (game) computers. Overall, families with an authoritative or authoritarian parenting style had lower percentages of children's screen time compared to families with an indulgent or neglectful style, but no significant difference in odds ratio was found. Children in families with rules and parental monitoring (i.e. parenting practices; characteristics of the social home environment) regarding watching TV were less likely to watch TV >2 hrs/day. Children with higher autonomy regarding watching TV were more likely to watch TV >2 hrs/day. Further, having multiple TVs within the household and a TV in the child's bedroom (i.e. characteristics of the physical home environment) was associated with higher odds for watching TV >2 hrs/day. Overall, the results for spending >30 min/day on (game) computers were comparable to these results for watching TV >2 hrs/day. The parenting practices appeared to mediate the association between the parenting style dimension involvement and children's use of (game) computers. Further, parenting style appeared not to be an effect-modifier in any of the associations between the social and physical home environment characteristics and children's screen time.

Finally, in **chapter 8**, the main findings of this thesis are presented and discussed in a broader context. In addition, methodological issues are discussed. Further, recommendations for

future research and recommendations for the practice setting are given. The final conclusion of this thesis is the following:

In Dutch youth healthcare, BMI is used to for the identification of overweight and obesity in children. There appears to be moderate agreement between BMI and measures of WC on the presence of overweight among 5-year-old children. BMI might not be a sensitive marker for overweight among relatively tall or short children. Future research should investigate whether WC should be measured in addition to BMI to improve early identification of children at increased risk for developing overweight-related health problems, and whether this approach is cost-effective.

Already at the start of elementary school, children of lower SES subgroups and of Moroccan and Turkish ethnic background are at increased risk for overweight and obesity. It is therefore important to give special attention to these riskgroups. More insight is needed into the attitude and potential perceived barriers regarding healthy dietary and physical activity behavior of these subgroups, for example by using qualitative research. Special attention should be given to parental weight status, having breakfast and watching TV in the household for these subgroups. To reach, motivate and support specific subgroups in behavioral change to prevent overweight and obesity, special efforts and adjustments of the protocol might be needed, and social marketing techniques could be used.

Children who do not have breakfast every day and children who watch TV for more than 2 hours per day are at increased risk for overweight (obesity included). Further, the more risk behaviors (not having breakfast every day, drinking more than 2 glasses of sweet beverages per day, playing outside less than 1 hour per day, and watching TV for more than 2 hours per day) are present, the higher the risk for having overweight and obesity. It is recommended to focus on and monitor lifestyle-related behavior during well-child visits, before adverse habits are established.

At the age of 5 years, there appear to be relatively modest associations between parenting style and children's screen time, and the social and physical home environment appeared to have unique effects on children's screen time that are independent of parenting style. To reduce children's screen time, it might be most effective when the overweight prevention protocol provides more specific guidelines for youth healthcare professionals to help parents with changing their child's behavior, for example for supporting parents to introduce and monitor family rules related to screen time, and for preventing parents to place a TV or (game) computer in the child's bedroom.

The new insights into overweight assessment and risk factors for overweight in young children described above might contribute to the improvement of prevention of childhood overweight and obesity.

SAMENVATTING

Overgewicht en obesitas bij kinderen is wereldwijd een belasting voor kind, ouders en de gezondheidszorg. De preventie van overgewicht en obesitas op de kinderleeftijd is internationaal een prioriteit voor de volksgezondheid. In Nederland is de prevalentie van overgewicht en obesitas bij kinderen meer dan verdubbeld sinds 1980, in 2009 had circa 14% overgewicht en 2.0% obesitas. In 2004 is het 'Signaleringsprotocol overgewicht in de jeugdgezondheidszorg' in Nederland verschenen. Volgens dit protocol worden voor het vaststellen van de gewichtsstatus van kinderen, de leeftijd- en geslachtspecifieke afkappunten voor de body mass index (BMI) gebruikt, van de 'international obesity task force' (IOTF). In 2005 is vervolgens het preventieprogramma 'Overbruggingsplan voor kinderen met overgewicht' voor de jeugdgezondheidszorg verschenen. Bij deze interventie ligt de focus op de volgende 5 elementen; 1) het stimuleren van het geven van borstvoeding, 2) het stimuleren van regelmatig ontbijten, 3) het verminderen van het drinken van zoete dranken, 4) het stimuleren van lichamelijke activiteit (en buitenspelen in het bijzonder), en 5) het verminderen van TV kijken en het gebruiken van (spel)computers. Om de effectiviteit van het Overbruggingsplan te bepalen was vervolgens onderzoek nodig waarin het Overbruggingsplan geïmplementeerd werd binnen de jeugdgezondheidszorg en waarmee de effecten van het Overbruggingsplan bepaald konden worden. Na ontwikkeling en implementatie van een interventie moet de interventie continu geëvalueerd worden en op basis van deze evaluatie worden aangepast, verfijnd en verbeterd om zo de kwaliteit van de interventie te verbeteren.

Het hoofddoel van dit proefschrift is het verschaffen van nieuwe inzichten in het vaststellen van overgewicht en in de risicofactoren voor overgewicht bij jonge kinderen.

De eerste doelstelling van dit proefschrift is het ontwikkelen van een onderzoek waarmee het Overbruggingsplan geïmplementeerd en geëvalueerd kan worden. **Hoofdstuk 2** van dit proefschrift beschrijft de ontwikkeling en het design van het onderzoek 'Lekker bewegen, goed eten'. In dit onderzoek werd het Overbruggingsplan geïmplementeerd, en het doel van het onderzoek was het vaststellen van de effecten van het Overbruggingsplan op BMI, middelomtrek en gezondheidsgerelateerd gedrag van kinderen. Een cluster-randomized controlled trial werd uitgevoerd waaraan 5-jarige kinderen en hun ouders meededen. Het heeft de voorkeur interventies ter preventie van overgewicht zo vroeg mogelijk in het leven te starten. Kinderen werden geïncludeerd op de leeftijd van 5 jaar, omdat op die leeftijd alle kinderen en ouders in Nederland uitgenodigd worden voor een regulier preventief gezondheidsonderzoek (PGO) door jeugdgezondheidszorgprofessionals van de GGDen. Van de in totaal 37 GGDen in Nederland, wilden 9 GGDen met 44 teams van jeugdgezondheidszorg professionals meedoen aan het onderzoek. De 44 deelnemende jeugdgezondheidszorgteams werden random toegewezen aan de interventie of aan de controle groep. In totaal

werden 13,638 ouders van 5-jarige kinderen per post uitgenodigd voor een gratis PGO door één van de 9 GGDen. Van de ouders gaf 64.4% (n=8784) schriftelijke toestemming voor deelname aan het 'Lekker bewegen, goed eten' onderzoek. De jeugdgezondheidszorgprofessionals voerden metingen uit van het gewicht, de lengte en de middelomtrek van alle kinderen gedurende de PGO's. Wanneer een kind werd gesignaleerd met overgewicht in de interventie groep, dan werd het Overbruggingsplan toegepast. Volgens dit protocol werden ouders van kinderen met overgewicht uitgenodigd voor maximaal drie extra vervolgconsulten, waarin zij persoonlijk advies kregen over een gezonde leefstijl en waarin ze gemotiveerd werden voor gedragsverandering en daar ook bij geholpen werden. Ouders vulden vragenlijsten in met items over de vier leefstijl-gerelateerde gedragingen die onderzocht werden in het 'Lekker bewegen, goed eten' onderzoek (ontbijten, drinken van zoete dranken, buitenspelen (als indicator voor lichamelijke activiteit), en TV kijken en het gebruik van (spel)computers), opvoedingsstijl, opvoedingspraktijken en karakeristieken van de thuisomgeving. Baselinegegevens werden verzameld gedurende het schooljaar 2007-2008 toen de kinderen 5 jaar oud waren, en vervolgens werden gegevens verzameld na 12 en 24 maanden. De baselinegegevens zijn gebruikt voor de hoofdstukken 3 tot en met 7 van dit proefschrift. Het Overbruggingsplan is ondertussen geëvalueerd en de effecten van de interventie zijn gerapporteerd; kleine effecten op gezondheidsgerelateerd gedrag en BMI van de kinderen werden gevonden. De nieuwe inzichten die worden beschreven in dit proefschrift kunnen gebruikt worden om het Overbruggingsplan aan te passen. Toekomstig onderzoek moet uitwijzen of deze aanpassingen resulteren in meer effecten van het Overbruggingsplan.

De tweede doelstelling van dit proefschrift is het onderzoeken van de overeenstemming tussen de BMI en metingen van de middelomtrek bij het vaststellen van overgewicht bij 5-jarige kinderen. **Hoofdstuk 3** van dit proefschrift beschrijft de vergelijking tussen de BMI en de middelomtrek en de vergelijking tussen de BMI en de middelomtrek-lengte-ratio (MLR) voor het vaststellen van overgewicht bij 5-jarige kinderen. Over het geheel gezien waren BMI versus middelomtrek en BMI versus MLR maar matig met elkaar in overeenstemming wat betreft de aanwezigheid van overgewicht bij 5-jarigen. In de groep kinderen met overgewicht volgens de BMI, had meer dan éénderde geen overgewicht volgens de middelomtrek of de MLR. Ook in de groep kinderen met overgewicht volgens de middelomtrek, had meer dan éénderde geen overgewicht volgens de BMI. In de groep kinderen met overgewicht volgens de MLR had meer dan de helft van de totale groep alleen overgewicht volgens de MLR. Verder lieten de resultaten zien dat BMI en middelomtrek voornamelijk overeenkomen bij kinderen met het meeste lichaamsvet en buikvet. Bovendien bleek uit de resultaten dat BMI wellicht geen sensitieve marker is voor overgewicht bij relatief lange of korte kinderen.

De derde doelstelling van dit proefschrift is het onderzoeken van de associaties tussen sociaaleconomische status (SES), etnische achtergrond, en overgewicht en obesitas bij 5-jarige

kinderen. **Hoofdstuk 4** van dit proefschrift beschrijft de associatie tussen opleidingsniveau van de moeder, als indicator voor SES, en overgewicht en obesitas bij kinderen. Tussen opleidingsniveau van de moeder en overgewicht, en tussen opleidingsniveau van de moeder en obesitas, werden negatieve associaties gevonden. Deze associaties konden voor respectievelijk meer dan 25% en meer dan 40% worden toegeschreven aan TV kijken door de moeder en het kind, ontbijten door het kind, en vooral door gewichtsstatus van de moeder. **Hoofdstuk 5** beschrijft de verschillen in prevalentie van overgewicht (inclusief obesitas) tussen subgroepen van 5-jarige kinderen met een verschillende etnische achtergrond. In vergelijking met Nederlandse kinderen, hadden kinderen met een Marokkaanse en Turkse achtergrond een verhoogd risico voor het hebben van overgewicht. Als hierbij rekening gehouden werd met gewichtsstatus van de ouder, dan verminderde de odds voor overgewicht voor Marokkaanse kinderen met 10.2% en voor Turkse kinderen met 12.5%. Als ook TV kijken en ontbijten door het kind werd meegenomen, dan verminderde de odds nog eens met respectievelijk 7.9% en 12.2%. Het risico voor het hebben van overgewicht voor kinderen met een Antilliaanse etnische achtergrond verschilde niet van het risico voor Nederlandse kinderen. Surinaamse kinderen hadden een lager risico voor het hebben van overgewicht. Verder wezen de resultaten van dit onderzoek erop dat de effecten van etnische achtergrond mogelijk onafhankelijk zijn van de effecten van SES op het risico voor overgewicht en obesitas bij kinderen.

De vierde doelstelling van dit proefschrift is het onderzoeken van de assocaties tussen leefstijlgerelateerd gedrag en overgewicht bij 5-jarige kinderen, en dit wordt beschreven in **hoofdstuk 6**. Kinderen die niet elke dag ontbeten en kinderen die >2 uur/dag TV keken, hadden een verhoogd risico op het hebben van overgewicht (inclusief obesitas). Verder werd gevonden dat als het aantal risicogedragingen (niet elke dag ontbijten, >2 glazen zoete dranken drinken/dag, <1 uur/dag buitenspelen, en >2 uur/dag TV kijken) bij deze jonge kinderen toenam, ook het risico op het hebben van overgewicht (inclusief obesitas) toenam.

Ten slotte is de vijfde doelstelling van dit proefschrift het onderzoeken van de associaties tussen opvoedingsstijl van de ouders, de thuisomgeving en de tijd die kinderen van 5 jaar besteden aan het kijken naar een beeldscherm. Dit wordt beschreven in **hoofdstuk 7** van dit proefschrift. Kinderen van ouders met een hogere score op de opvoedingsstijldimensie betrokkenheid, bleken meer geneigd >30 min/dag te besteden aan een (spel)computer. Over het geheel gezien, besteedden kinderen in gezinnen met een autoritatieve of autoritaire opvoedingsstijl minder tijd aan het kijken naar een beeldscherm in vergelijking met kinderen in gezinnen met een toegevende of onverschillige opvoedingsstijl, maar er werd geen verschil in odds ratio gevonden. Kinderen in gezinnen met regels over TV kijken en ouders die het TV kijken van hun kind in de gaten houden (oftewel opvoedingspraktijken; kenmerken van de sociale thuisomgeving), keken minder vaak >2 uur/dag TV. Kinderen die voor zichzelf konden bepalen of ze TV kijken, keken vaker >2 uur/dag TV. Verder waren het aantal TV's in

het gezin en een TV in de eigen slaapkamer van het kind (oftewel kenmerken van de fysieke thuisomgeving) geassocieerd met een hogere odds voor >2 uur/dag TV kijken. Over het geheel gezien, waren de resultaten voor het gebruiken van (spel)computers voor >30 min/dag, vergelijkbaar met die voor TV kijken. De opvoedingspraktijken bleken de associatie tussen de opvoedingsstijldimensie betrokkenheid en het (spel)computer gebruik van de kinderen te mediëren. Daarnaast bleek opvoedingsstijl geen effectmodificator te zijn in de associaties tussen de kenmerken van de sociale of de fysieke thuisomgeving en de tijd die kinderen besteden aan het kijken naar een beeldscherm.

Tot slot worden in **hoofdstuk 8** de belangrijkste bevindingen van dit proefschrift gepresenteerd en bediscussieerd in een bredere context. Daarnaast worden methodologische aspecten aangehaald. Verder worden aanbevelingen gedaan voor toekomstig onderzoek en voor de praktijk. De uiteindelijke conclusie van dit proefschrift is als volgt:

In de Nederlandse jeugdgezondheidszorg wordt de BMI gebruikt om overgewicht en obesitas bij kinderen vast te stellen. Voor het vaststellen van overgewicht bij 5-jarige kinderen blijken BMI en de middelomtrekmaten maar matig met elkaar in overeenstemming te zijn. BMI is mogelijk geen sensitieve marker voor overgewicht bij kinderen die relatief lang of kort in lengte zijn. Toekomstig onderzoek moet uitwijzen of middelomtrek gemeten moet worden in aanvulling op de BMI om vroege opsporing van kinderen met een verhoogd risico op het ontwikkelen van overgewichtgerelateerde gezondheidsproblemen te verbeteren, en of deze aanpak kosten-effectief is.

Bij de start van de basisschool hebben kinderen uit subgroepen met een lagere SES en kinderen met een Marokkaanse of Turkse etnische achtergrond al een verhoogd risico op overgewicht en obesitas. Het is dan ook van belang extra aandacht te geven aan deze risicogroepen. Meer inzicht is nodig in de belevingswereld en in de mogelijke barrières die deze subgroepen ondervinden ten opzichte van gezond eet- en beweeggedrag, bijvoorbeeld door middel van kwalitatief onderzoek. Specifieke aandacht zou besteed moeten worden aan de gewichtsstatus van de ouder, ontbijten en TV kijken in het huishouden bij deze specifieke subgroepen. Voor het bereiken, motiveren en het ondersteunen van specifieke subgroepen bij gedragsverandering om overgewicht en obesitas te voorkomen, zijn mogelijk aanpassingen van het Overbruggingsplan nodig, en social marketingtechnieken zouden gebruikt kunnen worden.

Kinderen die niet elke dag ontbijten en kinderen die meer dan 2 uur per dag TV kijken, hebben een verhoogd risico op overgewicht (inclusief obesitas). Verder, hoe meer risicogedragingen (niet elke dag ontbijten, meer dan 2 glazen zoete dranken drinken op een dag, minder dan 1 uur per dag buitenspelen, en meer dan 2 uur TV kijken op een dag) aanwezig, hoe hoger het

risico op overgewicht en obesitas. Het is aan te bevelen om gedurende PGO's op leefstijlgerelateerde gedragingen te richten en deze te monitoren, voordat nadelige gewoonten zijn ontstaan.

Op 5-jarige leeftijd blijken de associaties tussen opvoedingsstijl en de tijd die kinderen besteden aan het kijken naar een beeldscherm matig te zijn. Verder blijken de effecten van de sociale en fysieke thuisomgeving op deze 'beelschermtijd' van 5-jarige-kinderen onafhankelijk te zijn van de opvoedingsstijl. Voor het verminderen van 'beeldschermtijd' van kinderen is het mogelijk het meest effectief meer specifieke richtlijnen op te nemen in het Overbruggingsplan waarmee jeugdgezondheidszorgprofessionals ouders kunnen helpen het gedrag van hun kind te veranderen, bijvoorbeeld voor het ondersteunen van ouders bij het invoeren en monitoren van regels in het gezin over 'beeldschermtijd', en om te voorkomen dat ouders een TV of (spel)computer in de slaapkamer van het kind plaatsen.

De hierboven beschreven nieuwe inzichten in het vaststellen van overgewicht en de risicofactoren voor overgewicht bij jonge kinderen kunnen mogelijk bijdragen aan de verbetering van de preventie van overgewicht en obesitas op de kinderleeftijd.

Dankwoord

Curriculum Vitae

Publications

PhD Portfolio

DANKWOORD

Ook bij het schrijven van een proefschrift hebben naast individuele factoren, factoren in de omgeving grote invloed! Ik wil hier alle mensen bedanken die op verschillende manieren hebben bijgedragen aan mijn proefschrift.

In de eerste plaats mijn eerste promotor, Hein Raat. Hein, bedankt dat je mij de mogelijkheid hebt gegeven te promoveren op het 'Lekker bewegen, goed eten' onderzoek. Bedankt voor je begeleiding en dat je mij de ruimte gaf uit te groeien tot een zelfstandig en kritisch onderzoeker. Hierdoor heb ik enorm veel geleerd. Mijn tweede promotor, Remy HiraSing. Remy, ik heb veel waardering voor je positieve en enthousiaste instelling en 'hart voor de zaak'. Heel veel dank voor je betrokkenheid en je begeleiding gedurende mijn promotietraject. Ik heb veel gehad aan onze inhoudelijke discussies gedurende onze vele en vaak lange telefoongesprekken. En wie weet treffen wij elkaar in de toekomst nog eens op de kermis in Hoorn :-). Mijn co-promotor, Carry Renders. Carry, veel dank voor je betrokkenheid, en je input en ondersteuning bij zowel de uitvoering van het onderzoek als bij mijn promotietraject. Het was fijn dat ik altijd bij je terecht kon voor advies. Leden van de kleine commissie, prof.dr. H.A. Moll, prof.dr. J.J. van Busschbach en dr. M.M. Boere-Boonekamp, en leden van de grote commissie, dank voor de tijd en aandacht die jullie aan mijn proefschrift hebben besteed. Johan, ik wil ook jou bedanken voor de aandacht die je aan mijn proefschrift hebt besteed en je input gedurende mijn promotietraject. Verder wil ik alle co-auteurs bedanken voor hun bijdrage aan de artikelen van mijn proefschrift.

Vanaf de start van het 'Lekker bewegen, goed eten' onderzoek zijn heel veel verschillende mensen betrokken geweest bij het onderzoek. Ten eerste wil ik alle GGD'en, jeugdgezondheidszorgmedewerkers, ouders en kinderen bedanken voor hun deelname aan het 'Lekker bewegen, goed eten' onderzoek. Willemieke, dank voor je hulp bij het opzetten van het onderzoek, ik heb veel van je geleerd. Ineke, bedankt voor je hulp bij de analyses en het schrijven van de artikelen. Mirjam, ik kijk met veel plezier terug op de tijd dat wij intensief samenwerkte aan de uitvoering van het onderzoek. Ook wil ik Joop en Mara bedanken voor hun inzet gedurende de tijd dat ze bij het onderzoek stage liepen. Ik vond het erg leuk jullie te begeleiden. Ook wil ik alle onderzoeksmedewerkers, de dames van het secretariaat, en de mannen van databeheer en de statistiek bedanken voor hun hulp en ondersteuning. Amy, jij hebt het stokje van mij overgenomen en het onderzoek tot een goed einde gebracht. Ik kon het onderzoek met een gerust hart aan jou overdragen.

Lenneke, wat had ik een geluk dat ik jarenlang een kamer én lief&leed met jou mocht delen. Bovendien heb ik veel van je geleerd. Ik ben heel blij dat je naast me staat als paranimf. Mariëlle en Suzan, bedankt voor alle gezelligheid en jullie betrokkenheid. Ik heb erg geno-

ten van de reis van ons vieren naar de USA. Meiden, wat fijn dat we elkaar nog regelmatig zien. Ik hoop op nog heel veel gezelligheid met elkaar! Mirjam, ik wil jou speciaal bedanken voor de gezellige theemomentjes en je hulp en luisterende oor in de laatste fase van mijn proefschrift. En alle andere oud-collega's van MGZ, waaronder Rick, Ilse, Nicolien, Wendy, Else, Ilke, Noortje, Meeke, Marieke, Nicole, Esther, Lenie, maar ook van het IVO en de sectie Jeugd&Gezondheid van het VUmc, veel dank voor jullie interesse, gezelligheid, fijne gesprekken, wandelingen, het volleyballen, koffie-momentjes, borrels, etentjes en andere uitjes. Het was ook altijd fijn om mijn baksels bij jullie 'kwijt te kunnen' :-).

Vrienden en (schoon)familie, bedankt voor jullie interesse in mijn onderzoek. Mijn lieve vriendinnetjes Marieke, Petra, Mirte, Mariska en Renée (oftewel de 'balletmeiden'), dank voor de afleiding de afgelopen jaren in de vorm van alle gezellige avondjes, uitjes en weekendjes weg. Mariska en Quintin, Gert en Yvonne, en Oma, bedankt voor jullie interesse en steun. Pap en mam, heel veel dank voor alle support en jullie onvoorwaardelijke liefde. Het is fijn om te merken dat jullie zo trots op me zijn. Renée, ik ben trots op je en blij dat je naast me staat als zus en paranimf.

Lieve Maikel, wat fijn dat je er altijd voor me bent. Hou van jou!

CURRICULUM VITAE

Lydian Kogenhop-Veldhuis was born in Hoorn, the Netherlands, on the 30th of June 1983. In 2001, she finished her pre-university education at Scholengemeenschap Tabor, location Oscar Romero, in Hoorn and started her study Health Sciences at the VU University in Amsterdam. She obtained her Bachelor of Science degree in Health Sciences in 2004. After following a two-year Master's program, she obtained her Master of Science degree in Biomedical Sciences, specialization Public Health Research, in 2006. In 2007 she started as a junior researcher at the Department of Public Health of the Erasmus MC in Rotterdam, the Netherlands, where she initiated the study 'Be active, eat right'. In 2011 and 2012 she worked as a researcher at the IVO Addiction Research Institute in Rotterdam where she carried out several research projects on lifestyle of youth. In 2012 and 2013 she worked a few months as a researcher at the Department of Public and Occupational Health/EMGO Institute for Health and Care Research, section Child Health and Care Research of the VU University Medical Center in Amsterdam, the Netherlands.

Lydian Kogenhop-Veldhuis is geboren in Hoorn op 30 juni 1983. In 2001 behaalde ze haar VWO diploma aan de Scholengemeenschap Tabor, locatie Oscar Romero, in Hoorn en startte ze met de studie Algemene Gezondheidswetenschappen aan de Vrije Universiteit in Amsterdam. In 2004 studeerde ze af voor de bachelor Algemene Gezondheidswetenschappen. Na het volgen van een 2-jarige masteropleiding, studeerde ze in 2006 af voor de master Biomedische Wetenschappen, specialisatie 'Public Health Research'. In 2007 begon ze als junior onderzoeker op de afdeling Maatschappelijke Gezondheidszorg van het Erasmus MC in Rotterdam, waar ze het onderzoek 'Lekker bewegen, goed eten' heeft opgezet. In 2011 en 2012 werkte ze als onderzoeker bij het IVO Instituut voor Onderzoek naar Leefwijzen en Verslaving waar ze verschillende onderzoeken heeft uitgevoerd op het gebied van leefstijl van jongeren. In 2012 en 2013 heeft ze een aantal maanden gewerkt als onderzoeker op de afdeling Sociale Geneeskunde/EMGO Instituut voor Onderzoek naar Gezondheid en Zorg, sectie Jeugd en Gezondheid van het VU Medisch Centrum, Amsterdam.

PUBLICATIONS

Veldhuis L, Van Dooremaal M, Kroeze W, Renders CM, Hirasing RA, Raat H. Ethnic background and overweight among 5-year-old children; the 'Be active, eat right' study. *ISRN Pediatrics*. 2013;2013:861246.

Rodenburg G, Veldhuis L, Schoenmakers TM. Pilot-implementatie 'Protocol voor signalering, screening en kortdurende interventie van risicovol alcoholgebruik bij jongeren'. Procesevaluatie bij het implementatieproject in de GGD-regio Zuid-Holland Zuid. Rapport. Rotterdam: IVO Instituut voor Onderzoek naar Leefwijzen en Verslaving, onderzoek gefinancierd door ZonMw Gezonde Slagkracht; 2013 July.

van Grieken A, Veldhuis L, Renders CM, Landgraf JM, Hirasing RA, Raat H. Impaired parent-reported health-related quality of life of underweight and obese children at elementary school entry. *Qual Life Res*. 2013;22(4):917-928.

Veldhuis L, Vogel I, van Rossem L, Renders CM, Hirasing RA, Mackenbach JP, Raat H. Influence of maternal and child lifestyle-related characteristics on the socioeconomic inequality in overweight and obesity among 5-year-old children; the "Be active, eat right" study. *International journal of environmental research and public health*. 2013;10(6):2336-2347.

van Grieken A, Veldhuis L, Renders CM, Borsboom GJ, van der Wouden JC, Hirasing RA, Raat H. Population-based childhood overweight prevention: outcomes of the 'Be active, eat right' study. *PloS one*. 2013;8(5):e65376.

Veldhuis L, Vogel I, Jansen W, Renders CM, Hirasing RA, Raat H. Moderate agreement between body mass index and measures of waist circumference in the identification of overweight among 5-year-old children; the 'Be active, eat right' study. *BMC pediatrics*. 2013;13:63.

Van Duin L, Schoenmakers TM, Veldhuis L, Janikian M. Risico's in internetgebruik door jongeren. Verslag over de Nederlandse jongeren binnen een Europees onderzoek naar risicovol en verslavend internetgebruik. Factsheet. Rotterdam: Center for Behavioral Internet Science, IVO Instituut voor Onderzoek naar Leefwijzen en Verslaving; januari 2013.

Dreier M, Tzavela E, Wölfing K, Mavromati F, Duven E, Karakitsou C, Macarie G, Veldhuis L, Wójcik S, Halapi E, Sigursteindottir H, Oliaga A, Tsitsika A. The development of adaptive and maladaptive patterns of Internet use among European adolescents at risk for Internet addictive behaviors: A Grounded theory inquiry. Report. EU NET ADB Consortium, project funded under the Safer Internet plus programme; 2012.

Veldhuis L, Schrijvers C. Naar een integrale aanpak van genotmiddelengebruik door cluster 4 leerlingen van het Voortgezet Speciaal Onderwijs. Een beschrijving van de huidige en gewenste aanpak op het Schreuder College in Rotterdam. Rapport. Rotterdam: IVO Instituut voor Onderzoek naar Leefwijzen en Verslaving, onderzoek in opdracht van CEPHIR, Klein maar Fijn; 2012.

Veldhuis L, Vogel I, Renders CM, van Rossem L, Oenema A, HiraSing RA, Raat H. Behavioral risk factors for overweight in early childhood; the 'Be active, eat right' study. *The international journal of behavioral nutrition and physical activity*. 2012;9:74.

Veldhuis L, Koppes LL, Driessen MT, Samoocha D, Twisk JW. Effects of dietary fibre intake during adolescence on the components of the metabolic syndrome at the age of 36 years: the Amsterdam Growth and Health Longitudinal Study. *J Hum Nutr Diet*. 2010;23(6):601-608.

Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM, Hirasing RA, Raat H. 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC public health*. 2009;9:177.

Driessen MT, Koppes LL, Veldhuis L, Samoocha D, Twisk JW. Coffee consumption is not related to the metabolic syndrome at the age of 36 years: the Amsterdam Growth and Health Longitudinal Study. *European journal of clinical nutrition*. 2009;63(4):536-542.

PHD PORTFOLIO

Summary of PhD training and teaching

Name:	Lydian Veldhuis
PhD period:	2007-2010
Erasmus MC Department:	Public Health
Promotors:	Prof.dr. H. Raat
	Prof.dr. R.A. HiraSing
Co-promotor:	Dr. C.M. Renders
Supervisor:	Prof.dr. H. Raat

	Year	Workload (ECTS)
1. PhD training		
Courses		
- Biomedical English Writing and Communication, Erasmus MC, Rotterdam, the Netherlands	2009	4.0
- Cursus Access, Opleidingscentrum, Erasmus MC, Rotterdam, the Netherlands	2008	0.3
Seminars and workshops		
- PhD Day Erasmus University Rotterdam, the Netherlands	2010	0.1
- NWO-Talent Class "Kernachtig formuleren", Den Haag, the Netherlands	2010	0.4
- ZonMw-workshop "Indienen in het programma Preventie: Prioriteiten, procedure en projectidee schrijven", Den Haag, the Netherlands	2010	0.2
- PhD Day Erasmus MC, Rotterdam, the Netherlands	2010	0.1
- Voorjaarssymposium Nederlandse Associatie voor de Studie van Obesitas, Den Bosch, the Netherlands	2009	0.3
- Themabijeenkomst "Overgewicht bij de Nederlandse jeugd", Vereniging voor Bewegingswetenschappen Nederland, VU University, Amsterdam, the Netherlands	2007	0.1
- Workshop "Introductie in de Theorie en Praktijk van Motivational Interviewing", Centre for Motivation & Change, Hilversum, the Netherlands	2007	1.0
- Seminars at the Department of Public Health and Department of Epidemiology, seminars of CEPHIR and Generation R, Erasmus MC, Rotterdam, the Netherlands	2007-2010	3.6
Presentations		
- "Home and family influences on sedentary behavior in 5-year-old children", oral presentation, 9th Annual Conference of the International Society of Behavioral Nutrition and Physical Activity, Minneapolis, USA	2010	1.0
- "Assessment of overweight among 5-year-old children; comparison of body mass index and waist circumference", oral presentation, 9th Annual Conference of the International Society of Behavioral Nutrition and Physical Activity, Minneapolis, USA	2010	1.0
- "Motiverende gespreksvoering binnen het onderzoek 'Lekker bewegen, goed eten': onderzoek naar overgewicht bij kinderen", oral presentation, Institute of Health Sciences, Faculty of Earth and Life Sciences, VU University, Amsterdam, the Netherlands	2010	0.6
- "Having family breakfast daily and overweight among 5-year-old children", oral presentation, 8th Annual Conference of the International Society of Behavioral Nutrition and Physical Activity, Lisbon, Portugal	2009	1.0
- "Parent's educational level and their child's nutritional behavior and physical activity", poster presentation, 8th Annual Conference of the International Society of Behavioral Nutrition and Physical Activity, Lisbon, Portugal	2009	0.6

-	"Prevention of overweight and obesity by education and counseling in preventive youth health care", poster presentation, 17th European Congress on Obesity, Amsterdam, the Netherlands	2009	0.6
-	"Ervaringen bij de uitvoer van een grote geclusterde gerandomiseerde trial (c-RCT): Lekker bewegen, goed eten", oral presentation, NWO retraite/Landelijk Netwerk Onderzoek Jeugd&Gezondheid, Soesterberg, the Netherlands	2009	0.6
-	"Onderzoeksproject 'Lekker bewegen, goed eten' werving en inclusie", oral presentation, NWO retraite/Landelijk Netwerk Onderzoek Jeugd&Gezondheid, Soesterberg, the Netherlands	2008	0.6
-	"Evaluatie van het Overgewicht Signaleringsprotocol en het Overgewicht Preventieprotocol voor 5-jarige kinderen in de Jeugdgezondheidszorg in een geclusterde gerandomiseerde trial", oral presentation, NWO retraite/Landelijk Netwerk Onderzoek Jeugd&Gezondheid, Soesterberg, the Netherlands	2007	0.6
(Inter)national conferences			
-	9th Annual Conference of the International Society of Behavioral Nutrition and Physical Activity, Minneapolis, USA	2010	1.0
-	8th Annual Conference of the International Society of Behavioural Nutrition and Physical Activity, Lisbon, Portugal	2009	1.0
-	17th European Congress on Obesity, Amsterdam, the Netherlands	2009	1.0
-	Nederlands Congres Volksgezondheid 2009 "Over bruggen en grenzen; beleid, onderzoek en praktijk", Rotterdam, the Netherlands.	2009	0.3
-	Jaarcongres Jeugdgezondheidszorg "Samen Sterker", Ede, the Netherlands	2008	0.3
-	NWO retraite/Landelijk Netwerk Onderzoek Jeugd & Gezondheid, Soesterberg, the Netherlands	2007-2009	1.5
2. Teaching			
-	Supervision Masters's thesis M. van Dooremaal, student Health Sciences at the VU University, Amsterdam, the Netherlands. Title thesis "Ethnic differences in overweight prevalence among young children"	2009	1.5
-	Supervision research internship J.W.M. Heijnen, medical student at the Erasmus University Rotterdam, the Netherlands. Title thesis "Prevalentie en Determinanten van Overgewicht en Obesitas bij 5-jarigen in Nederland. Lekker Bewegen, Goed Eten; 'Leefstijl, groei en gezondheid van kinderen van 4-7 jaar'"	2008-2009	1.5
-	Supervision of medical students of the Erasmus University Rotterdam, the Netherlands, in writing assignments, course "De populatie als patiënt"	2008-2010	0.3
3. Other activities			
-	Reviewer several international scientific journals (Applied Physiology Nutrition and Metabolism, Health Policy, and Diabetes Research and Clinical Practice)	2008/2010